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Entry and Exit of Plants into UK Manufacturing Industries, 1974-97

By

Parastoo Hassaszadeh

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Submitted for the Doctor of Philosophy in Economics

Department of Economics and Finance

University of Durham

January 2003

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Abstract

Entry and Exit of Plants into UK Manufacturing Industries, 1974-97

By Parastoo Hassaszadeh

Empirical work in relation to the entry and exit of plants in UK manufacturing industries has been affected by a lack of information available to researchers. This thesis provides evidence on the entry and exit of plants in UK manufacturing industries during the 1974-97 period, using the newly released ARD dataset. In order to provide a better understanding of entry and exit of plants the following aspects were investigated: 1) the magnitude of plant entry and exit in UK manufacturing sectors during the 1974-97 period; 2) the determinants of the entry decision; and 3) the determinants of the exit decision.

The findings revealed that UK manufacturing industries were characterised by a high level of dynamics. Competition was intense and was increasing especially towards the end of the 1990s period. Therefore, the notion of "creative destruction" appeared to be of particular relevance in UK manufacturing industries. In studying the entry decision, new plants were divided into three categories: 1) those opened by domestic de-novo firms; 2) those opened by domestic incumbents; and 3) those opened by foreign firms. It was found that: 1) different types of entrants showed significant differences in their entry behaviour; 2) both industrial and geographical specific factors affect the entry decision; 3) the role played by the industry life cycle could not be ignored, as the effect of some factors on entry significantly differed across the two different stages of the industry life cycle; and 4) fundamental differences between the northern and southern regions of the UK significantly affected the impact of given factors on entry. In studying the exit decision the most important findings were: 1) the role that the age of a plant played in determining the impact of some variables on its risk of closure; and 2) the positive impact of change in ownership on the risk of closure of plants.

The material contained in this thesis has not been previously submitted for a degree in this or any other university.

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To My Parents,

My Sisters

and My Late Grandparents

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Parastoo Hassaszadeh

January 2003

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Chapter 1: Introduction

Entry and exit are among the most important forces that determine the overall competitiveness of industries. According to Stigler (1968), "competition may be the spice of life, but in economics it has been more nearly the main dish" (p. 5). Therefore, the main focus of this thesis is to provide a better understanding of the determinants of plant opening and closure in UK manufacturing industries during the 1974-97 period. In order to carry out this task, this thesis investigates three main aspects of these two phenomenon: 1) it studies the performance of the firm population in UK manufacturing sectors during the 1974-97 period by analysing the components of firm turnover, which includes birth, death, growth and ultimate decline; 2) it provides a detailed study of plant opening decisions by (a) dividing the entrants into three different categories, based on certain characteristics; (b) looking at both the industrial and geographical factors that affect plant opening decisions; and (c) taking into account the stage in the industry life cycle when new entry occurs and the fundamental differences between the northern and southern regions of the UK; and 3) it studies the exit decision at plant level and examines the impact of various plant, industry, owner-enterprise, time and regional specific factors on this decision.

Previous empirical work in relation to entry and exit of plants in UK manufacturing industries has been affected by a lack of information available to researchers. This type of analysis has not been done for the UK manufacturing sectors as a whole, neither covering a long period of time. However, for the first time in the UK, the Office for National Statistics (ONS) has provided researchers with micro-based panel plant level data that provides various geographical, ownership, industrial and financial (such as sales and cost) information for plants in the manufacturing sector over a prolonged period of time. This data is contained in the Annual Respondent Database (ARD).

According to Caves (1998): "...although research on the turnover of business units has a long tradition, primary data on the full population of business units (firms or establishments) present in nations' markets were inaccessible until recently. Only in the past decade have economics picked the locks on the doors of numerous national census bureaus and organized the primary records so that the births, deaths and life trajectories of individual business units can be traced". Using data from the Canadian Census of Manufacturers, Baldwin (1995) provided a comprehensive study which analysed birth, death, growth and decline of the firm population in Canadian manufacturing industries over the 1970-82 period. However, such a study has not been carried out for the population of firms in UK manufacturing sectors. In an attempt to fill this gap, Chapter 3 provides such an analysis for UK manufacturing plants over the 1974-97 period.

The next step towards acquiring a better understanding of the determinants of plant turnover is to study the entry and exit decisions separately and to determine the importance of various factors on these decisions. Previous empirical work that has been done on the entry decision for the UK manufacturing industries either: 1) took a cross section of industries over a period of time and tried to explain their entry variations using some industry specific variables (e.g. Gorecki, 1975; Geroski, 1991a); or 2) looked at the spatial determinants of new firm formations (Ashcroft *et al.* 1991; Love, 1996). However, the industrial and spatial factors are equally important in the formation of new businesses and, according to Audretsch and Fritsch (1999): "...the ambiguous findings in the regional economic literature is the result of ignoring the role that industrial organization plays". Therefore, it is important to study these two aspects side by side.

At the same time, there exists a wide range of literature, in relation to the structural changes that affects industries as they go through various stages of their life cycle (Gort and Klepper, 1982; Hoff, 1997; Agarwal, 1998). According to Agarwal and Gort (1996) these observed structural changes in industries affect entry of new firms in two distinct ways: 1) it changes the value of the explanatory variables, such as the attributes of the industry; and 2) it changes the value of the parameters that relate entry to the explanatory variables.

The stage of the industry life cycle is not the only factor that can affect the relationship between the explanatory variables and entry. The fundamental differences between the northern and the southern regions of the UK, in a wide range of aspects such as regional growth, unemployment, rates of return on capital and new firm formation (Keeble and Walker, 1994; Love 1996; Martin, 1997; Harris and Andrew, 2000), can also affect the type of entrants and their magnitude in these regions. Therefore, if one wishes to study the plant entry decision comprehensively, it is necessary to take into account the industrial specific factors, the geographical specific factors, the stage of the industry life cycle and the geographical division between the north and the south of the UK, all of which affect the entry decision of plants. In the current study, the data provided by the ARD is used in order to obtain information regarding the characteristics of the industries and regions into which plants entered[1].

Therefore, in Chapter 4 entrants are divided into three different categories: 1) those opened by domestic de-novo firms; 2) those opened by domestic incumbents; 3) those opened by foreign firms. Next, using the GMM method of estimation, the entry rate for each group of entrants, into a specific industry, region and year is separately modelled. The explanatory variables in the models include industry specific factors and geographical specific factors. The stage of the industry life cycle and the geographical

[1] The ARD provides information regarding the region in which plants are located. However, the regional specific factors are obtained from Regional Trends (various issues).

division between the north and the south of UK are controlled for, by using two dummy variables.

With regard to plant exit previous empirical work, in terms of the determinants of exit for UK manufacturing industries, has also suffered from a lack of comprehensive data. These studies either looked at the determinants of exit at an industry level (Hamilton, 1985) or at a spatial level (Love, 1996). Therefore, they took an aggregate measure of exit (such as gross exit or exit rate) at an industry or spatial level and explained its variations using some industry or geographical specific factors. However, plant and owner-enterprise specific factors often play a much more important role vis-à-vis the industry or spatial specific factors. Therefore, a suitable model has to take into account all of these factors. Using a logit model, Deily (1991) looked at the plant and firms specific factors that affected the closure decision of 19 firms in the UK steel casting industry during the 1977-87 period. However, this study was carried out for only a limited number of firms.

The model that seems most capable of accommodating all these factors is the hazard model, which has been used to model exit in various studies for other countries (Boeri and Bellman, 1995; Mata *et al.* 1995). McCloughan and Stone (1998) used a hazard model in order to examine the exit decision of a selected number of foreign manufacturing plants in the UK Northern region. Disney *et al.* (1999) used the data contained in the ARD in order to study the exit decision of plants. However, they were a number of shortcomings related to the latter study[2].

[2] They used establishments rather than plants as their units of analysis. They also used the selected file contained in the ARD, which was biased towards the large establishments and they did not weight the data to make it a representative of the entire population of the manufacturing plants. Finally, the number of variables that they used was limited, as they only studied the impact of employment size, initial size, output growth and cohort dummies on the hazard of plant closure.

Therefore, Chapter 5 of this thesis investigates the exit decision of plants. It uses a weighted selected number of plants in the manufacturing sectors and employs a time-varying covariates hazard model in order to study their exit decision. The hazard model accommodates a range of plant specific, industry specific and owner-enterprise specific factors.

The study's conclusions and recommendations are to be found in Chapter 6.

Chapter 2: Literature Review

2.1 Introduction

According to Thurik and Audretsch (1996), "the modern industrial organisation is characterised by a tremendous degree of turbulence. It is an organisation of industry with firms in motion, where a massive number of new firms enter each year, where only a subset survive for any length of time, and where an even smaller subset can ultimately challenge and displace the incumbent large enterprises" (pp. 150-151). Therefore, according to them, *entry* and *exit* are amongst the most important forces that shape the dynamics of industrial organization. They further stated that there are three important dimensions in the dynamics of industrial organization; time, space and industry. As the study of industrial organization shifts towards a more dynamic analysis, research has to focus on a variety of new influences such as time and space, along side the traditional industrial characteristics. Therefore, this chapter reviews the previous theoretical and empirical literature, paying attention to the various factors within these dimensions, which have been found to have an impact on entry and exit decisions.

In terms of factors that determine *entry*, Dean *et al.* (1993) divided them into supply and demand side factors. According to them, research investigating the differences in firm formation, across the geographical regions, usually looks at the supply side (or push) factors. These factors explore the non-materialistic incentives in starting up a new venture. On the other hand, those studies that examine the variations in firm formation, across industries, look at the demand side (or pull) factors, which are the monetary motivation in forming a new business. However, in this study, factors determining entry are going to be divided into *industrial specific factors* and *geographical specific factors*. The reason is that even at the spatial level there are variables that influence entry, through their impact on demand. This includes variables such as personal wealth or population density, both of which give rise to demand in the local market. According to Audretsch and Fritsch (1999), the industrial specific and geographical specific factors are equally important, in terms of their impact on the process of firm formation, and failure in taking account of either of them results in biased estimates.

In terms of factors that influence the *exit* decision, they are sub-divided into three major categories; *plant specific factors, owner-enterprise specific factors* and *industry specific factors*.

Therefore, Section 2.2 reviews the previous literature on the *entry* decision. Section 2.2.1 considers what differentiates between entries of *different groups of entrants*, based on certain attributes. These include entry of foreign firms, as opposed to domestic firms; entry of de-novo firms, as opposed to the already existing firms; and entry of small firms, as opposed to large firms. Factors that have been found to have an influence on entry decisions are divided into industrial specific and geographical specific factors. Section 2.2.2 reviews the previous theoretical and empirical literature, in relation to the impact of *industrial specific factors* on entry. The industrial specific factors are further divided into the following sub-categories: 1) those that were found to be an inducement to entry are reviewed in Section 2.2.2.1; 2) those that were found to be an impediment to entry are reviewed in Section 2.2.2.2; 3) those that have had an ambiguous effect on entry, in terms of being an inducement or an impediment are reviewed in Section 2.2.2.3; and 4) the impact of the industry's life cycle are reviewed in Section 2.2.2.4. The impediments to entry, which were reviewed in Section 2.2.2.2, are further divided into: 1) structural entry barriers, examined in Section 2.2.2.2.1; and 2) behavioural (or strategic) entry barriers, examined in Section 2.2.2.2.2. Section 2.2.3 reviews the previous literature, regarding the impact of *geographical specific factors* on entry.

Finally, Section 2.3 examines those factors that have been found to influence *exit* decisions. These are sub-divided into three categories: 1) *plant specific factors*, studied in Section 2.3.1; 2) *owner-enterprise specific factors,* studied in Section 2.3.2; and 3) *industry specific factors*, studied in Section 2.3.3[1].

2.2 Entry

2.2.1 Entry of different kinds of entrants

New entrants do not form a homogenous group, but rather have different attributes. Not only do they vary in size, but also they vary in terms of their ownership status (they can be owned by a foreign firm, as opposed to a domestic firm, or they can belong to a new firm, as opposed to an existing firm). According to Khemani and Shapiro (1988), ignoring the heterogeneity of entrants results in a biased estimate of the height of any entry barrier. Therefore, various studies have attempted to differentiate between entrants, based on these attributes. They typically have found that different kinds of entrants respond differently to the same industrial specific variables and show different entry behaviour. Given this, it is necessary to make a distinction between different kinds of entrants, if one wishes to study entry decisions.

Foreign entry versus domestic entry: An important cause of heterogeneity between entrants is their country of ownership, i.e. whether they are owned by a foreign enterprise or by a domestic enterprise. Caves (1971) explained that due to the advantages that foreign owned firms possess, it is easier for them to overcome various

[1] Note that, in studying exit decisions, geographical and time specific factors also have been taken into account. However, that is done by including dummy variables, in the regression model used in Chapter 5.

structural entry barriers[2]. He explains that if economies of scale are significant, but only present in one stage of production, then a foreign firm can carry out that stage at a single site and transfer the rest to its subsidiaries. Similarly, if a product differentiation barrier is present and created through patenting, then a foreign firm can use its knowledge in order to serve its markets across national boundaries. On the other hand, for markets where product differentiation is created through advertising, not only does present advertising can spill across national boundaries, but also previous advertising creates some accumulation of knowledge about marketing of the product and adapting it according to consumers' tastes. Finally, in those markets for which a large amount of start-up capital is required, and a high absolute cost barrier is present, there could be a high capital charge on borrowers if a large amount of capital is required. In this case, foreign firms have the advantage of buying factors of production either in the host or the home country, while domestic entrants have to chose only from one set of factor prices in their home country.

Having these advantages, foreign firms tend to enter industries that have high entry barriers. Therefore, the threat that incumbents encounter from the foreign entrants can be more serious than that from domestic entrants. Gorecki (1976), Khemani and Shapiro (1988) and Geroski (1991a) have made the distinction between foreign and domestic entrants and found significant differences between them regarding their entry behaviour. Overall, these results showed that domestic entrants were more sensitive to various sources of entry barriers than were foreign entrants.

De-novo entry versus entry by already existing firms: Hines (1957) argued that a certain types of entrants possess certain advantages in terms of being able to overcome

[2] Structural entry barriers will be explained in Section 2.2.2.2.1.

various sources of entry barriers. He made the distinction between entry by new firms (de-novo entry) and entry by already established firms. He argued that entry by established firms occurs more often than entry by new firms. However, the established firms are, in almost all respects, superior to the new firms, in terms of their ability to overcome various sources of entry barriers.

Khemani and Shapiro (1988) divided entrants into de-novo entrants, entry by already existing firms into the same industry and entry by already existing firms into a different industry. They concluded also that de-novo entrants are those that are the most sensitive to entry barriers. Mata (1993) made the distinction between de-novo entrants and entry by already existing firms. He further divided entry by the already existing firms into expansion, extension and purely diversifying entry[3]. He found that prospective de-novo entrants were deterred from entry into industries, which have high entry barriers and even where a large number of established firms entered.

Dunne *et al.* (1988) looked at the relative importance of different types of entrants, in terms of their gross number, employment share, survival and growth in US manufacturing industries. They found that de-novo entrants were high in absolute number, but accounted for a very small share of the industry's employment. They also had a lower survival rate than had other types of entrants and it took longer for them to reach the average size of incumbents. On the other hand, entry via acquisition or diversification occurred less, but their share of employment was higher and their growth was faster, relative to other types of entrants.

[3] If entry was in the same five-digit sector it was an extension entry. If it was into a different five-digit, but the same three-digit sector it was an expansion entry. Finally, if it was into a different three-digit sector, it was a purely diversifying entry.

Small-scale versus large-scale entry: Carlsson (1989) argued that small firm entry is a distinct phenomenon, in comparison with large firm entry, and small entrants behave differently than do their larger counterparts. Therefore, Acs and Audretsch (1989b) looked at the entry of small and large entrants separately and found significant differences in their entry decisions. They found that small-scale entrants usually operated in market niches, where they were less responsive to aggregate industry factors, such as industry profit and growth. However, they were deterred from entry into capital-intensive industries. On the other hand, profit and growth tended to affect large-scale entry positively.

Making the same distinction between entrants, Acs and Audretsch (1989a) found that small entrants were deterred from entry into concentrated industries, which had a high level of human capital and a high research and development intensity. At the same time, large entrants were more attracted towards concentrated industries and were not hindered by a high technology environment. Finally, Mata (1991) looked at the impact of sunk costs on the entry of small and large firms. He found that large-scale entry responded negatively to the magnitude of sunk costs and positively to the industry's growth. On the other hand, small entrants were attracted into industries with high levels of past profits. Overall, he concluded that large entrants were in a position of relative superiority vis-a-vis small entrants.

2.2.2 Industrial specific factors

2.2.2.1 Inducements to entry

Perceived profitability: Von der Fehr (1992) explained that entrants usually take present profits as a signal for post-entry profits because market prices are not a good indicator of future profits. High prices can be a result of either high costs or high demand, while entry is profitable only in the latter case. At the same time, getting information about prices, output or costs for outsiders is not easy and establishing price and output values are not always possible, unless the exact shape of the cost function is known. However, information about profits is more readily available e.g. through tax registers or dividend reports. Therefore, entrants usually take past or present profits as a proxy for future profits. Knowing this fact, established firms sometimes tend to manipulate their profits. They prefer to throw away profit and tolerate slack, in order to deter entry and protect their future long-run profits.

An important and interesting fact about profits is that they are affected by various factors. This can be better explained by going back to the Structure-Conduct-Performance paradigm. The traditional SCP framework assumed a causal relationship running from structure through conduct to performance. Within this framework finding the effect of concentration, which is an important element of the market structure on profitability measured by price (marginal) cost margins, became a common practice. Cowling and Waterson (1976) set up an explicit theoretical model to explain the effect of structure on performance. They showed that if the profit equation for firm i is

(1) $\pi_i = pX_i - c(X_i) - F_i$

where π denotes profit, p denotes market price, X denotes output, c denotes the variable cost of production, and F denotes the fixed cost of production and the market's inverse demand function is calculated according to the following equation;

(2) $p = f(X) = f(X_1 + X_2 + \ldots + X_N)$

then the first order profit maximization condition for firm i yields

(3) $\dfrac{d\pi_i}{dX_i} = p + X_i f'(X)\dfrac{dX}{dX_i} - c'(X_i) = 0$.

Cowling and Waterson assumed the existence of unequal sized firms, indicated by different marginal cost functions. Multiplying both sides of equation (3) by X_i and summing over N (number of firms), after some algebraic manipulation we obtain:

$$(4) \qquad \frac{\sum_{i=1}^{n} pX_i - \sum_{i=1}^{n} c'_i(X_i).X_i}{pX} = -\sum_{i=1}^{n} \left(\frac{X_i}{X}\right)^2 \frac{f'(X)X^2}{pX}(1+\mu)$$

where

$$\mu = \frac{\sum_{i=1}^{N} \lambda_i X_i^2}{\sum_{i=1}^{N} X_i^2}, \qquad \lambda_i = \frac{\partial \sum_{j \neq i} X_j}{\partial X_i}.$$

Assuming that firms have a constant marginal cost, equal to their average variable cost, the left side of the equation (4) will be equal to the ratio of profits plus fixed costs *(π+ F),* divided by revenue *(R)*. On the other hand, the first term on the right side of equation (4) will be equal to the Herfindahl measure of concentration. Therefore, the relationship can be rewritten as

$$(5) \qquad (\pi + F) / R = - H(1 + \mu) / \eta = - (v^2 + 1)(1 + \mu) / N\eta$$

where H is the Herfindahl measure of concentration, η is the price elasticity of demand and v is the coefficient of variation in output. This relationship explicitly shows that concentration and the reaction of other firms, to the firm's output change, have a positive effect on the level of profits in an industry. In contrast, higher price elasticity of demand tends to lower profitability, at the industry level. Clarke and Davis (1982) further extended this model and found that both concentration and profits are co-determined by N, η, α, v_c. The equation that they obtained was as follows:

$$\pi / R = (H(1 - \alpha) / \eta) + (\alpha / N)$$

where

$$H = \frac{1}{N} + \left\{1 - N\frac{(\eta - \alpha)}{(1-\alpha)}\right\}^2 \frac{v_c^2}{N}$$

where v_c is the coefficient of variation in marginal cost, due to efficiency differentials, and α is the degree of collusion. An important implication of their model was the positive effect of v_c on concentration and, consequently, on profits. This means that the greater the efficiency differentials between firms, indicated by different efficient levels of output, the higher is the coefficient of variation and, consequently, concentration and the profit revenue ratio. Therefore, it is possible to decompose the effect of market power and efficiency on profits. If there is no degree of collusion ($\alpha = 0$), then the level of profits obtained is a result of efficiency. However, by putting $0 < \alpha < 1$ one will have the level of profits, as a result of the joined effect of efficiency and market power. The difference between the two values is the pure effect of market power. This is in accordance with Demestz's (1973) proposition. He suggested that when some firms are more efficient and able to produce larger output and the size of the market is not very large, then the existence of a handful of efficient firms could satisfy demand. Therefore, this results in higher than normal profits, larger market shares and, consequently, higher concentration.

Overall, these models suggest that profitability in an industry is affected by various parameters and this could have an ambiguous effect of profitability on entry. The higher the level of profitability, the more attractive is the market for entrants. However, more profitable industries are also more concentrated ones, with fiercer retaliatory reaction from incumbents. Thus there is a conflicting effect of profitability on entry. This relationship was also investigated and confirmed by Kessides (1990).

The empirical work, regarding the effect of industry's profitability on entry, has mainly been based on the model developed by Orr (1974). This model takes the following general form;

$$E = \beta \left(\pi^{e} - F \right) + \mu$$

Therefore, based on a cross section of industries entry variations across them were explained by variations in the expected post-entry profits, minus the fixed costs of entry. However, the obtained coefficients were not usually large in value. Geroski (1995) explained that the profit variations across industries are mainly affected by the structural characteristics of the industries e.g. entry barriers. These structural characteristics are certain attributes of the markets and are stable over time. This means that most of the variations of profitability are across industries rather than over time variations. On the other hand, entry variations are more of a transitory nature and do not persist for a long time. The major source of entry variations is time variant factors such as demand shocks. They may affect certain industries for a short while, but they do not persist for a long time and as soon as the shock is over entry will go back to their normal level. Therefore, the correlation between entry and profitability, with different sources of variations, is not strong.

The following studies found that profits had a positive impact on entry (Orr, 1974; Harris, 1976; Dunne and Roberts, 1991; Schwalbach, 1991). Dividing the entrants into different categories, Geroski (1991a) found that only domestic entry responded to expected post-entry profits, while Gorecki (1976) found no such impact. Khemani and Shapiro (1988) found that both domestic and foreign entrants responded positively to industry profits. However, within the category of domestic entrants, de-novo entrants and entry by incumbents into the same industry in which they were already operating, responded positively, and diversifying entrants were insensitive to the industry's profits.

Mata (1993) found that industry profit only had a positive impact on expansion entry[4], while Khemani and Shapiro (1986) found a positive impact only for de-novo entry.

Looking at entry via plant creation versus plant acquisition, Baldwin and Gorecki (1987) found that industry profitability had no impact on the entry of either group. Dividing entrants based on their entry size, Acs and Audretsch (1989b) found that only entrants with employment larger than 250 responded positively to industry profits, while Acs and Audretsch (1989a) did not find such an impact.

Industries' growth rate of demand: Siegfried and Evans (1994) explained that entrants not only look at past profits, but also at the trend in profits or growth of industry demand, in order to infer future profits. If they believe that demand is going to grow faster than that expected by incumbents, then they enter, despite the already existing low levels of profits. This is because in an industry with high growth of demand, increases in output due to entry are not going to depress prices as much as in case of stable demand. However, growth in demand might not be enough to attract new entrants, as they might expect a more aggressive response from incumbents, who expect future demand to lessen. In any case, if an increase in demand is unanticipated and incumbents do not have enough time to adjust their output, then short-run profits can attract entry.

Growth has been found to have a positive impact on entry in the following studies (Orr, 1974; Hause and Du Rietz, 1984; Highfield and Smiley, 1987; Chappell *et al.* 1990; Schwalbach, 1991; Mayer and Chappell, 1992). Gorecki (1975) found that foreign entry responded positively to industry growth while despite expectations, Geroski (1991a) found that domestic entry responded negatively to growth (although the effect was only marginally significant). Khemani and Shapiro (1988) found that growth had a

[4] This is explained in the last footnote.

positive impact on the entry of all different kinds of domestic entrants, but not for foreign entrants. Baldwin and Gorecki (1987) found that industry growth only encourages entry by domestic de-novo entrants. Finally, Acs and Audretsch (1989a) and Acs and Audretsch (1989b) both found a positive impact of growth on entrants, with different sizes.

Exit (the replacement effect): There are two possible reasons to believe that the entry of firms can be caused by the exit of others from the market: a *replacement effect* and a *resource release.* Studying inter-industry differences in entry and exit for US manufacturing industries, Austin and Rosenbaum (1990) and Evans and Siegfried (1992) tested for the *replacement effect.* The reason, proposed by Evans and Siegfried, for the replacement effect was that previous exit leaves room in the market, which attracts new entrants. The second explanation for the causal relationship running from exit to entry is *resource release.* Brown *et al.* (1990) made the analogy between firms in an industry and 'trees of the forest'. They stated that exit feeds back into entry by freeing resources for more efficient new entrants. Storey and Jones (1987) considered this possibility, with respect to physical assets, in the sense that more second hand equipment will be available and at a cheaper price, when exit is frequent. According to Love (1996), another possibility is that exit releases entrepreneurial resources, which encourages self-employment.

Industry size: Geroski (1991a) proposed that the positive impact of industry size on entry could be due to two factors: 1) large industries have more potential niches for entrants to fit into; and 2) it is easier for firms to reach the Minimum Efficient Scale (MES) in larger industries, without provoking a reaction from other incumbents.

Industry size has been found to affect entry positively in various empirical studies e.g. Orr (1974), Khemani and Shapiro (1986), Chappell *et al.* (1990) and Mayer and Chappell (1992). Gorecki (1975) found that industry size affected the entry of both foreign and domestic firms positively. Khemani and Shapiro (1988), in their sample, also found that industry size had a positive impact on all the different types of entrants.

Existence of fringe firms (small firms) in industry: Dunne *et al.* (1988) showed that high entry and exit are due mainly to large movements amongst the small firms in and out of an industry. This effect is tested in the work of Rosenbaum and Lamort (1992) and Fotopoulos and Spence (1998). They both found that the existence of small firms in an industry had a positive impact on entry. Therefore, they concluded that existence of fringe firms indicates the potential for successful displacement of firms by entrants, which subsequently increases entry.

2.2.2.2 Impediments to entry

A common definition of entry barriers does not exist in the literature. Bain (1968) defines the condition of entry as "the extent to which, in the long-run, established firms can elevate prices above the minimal average costs of production and distribution...without inducing potential entrants to enter the industry" (p. 252). He then calls this level of price the 'limit price'. Therefore, the appropriate test according to his definition is whether prices are above minimal average costs, after entry has ceased. Stigler (1968) defines barriers to entry "as a cost of producing (at some or every rate of output), which must be borne by a firm which seeks to enter an industry, but is not borne by firms already in the industry" (p. 67). Similarly, Baumol *et al.* (1982) defines an entry barrier as "anything that requires an expenditure by a new entrant into an industry, but imposes no equivalent cost upon an incumbent" (p. 282). In both the Stigler and Baumol *et al.*'s definitions of entry barrier, the notion of cost asymmetry post-entry between entrants and incumbents is emphasised.

Weizsacker (1980) defines an entry barrier in a similar way as that proposed by Stigler, except that he argues that the cost differentials post-entry are a barrier only if they result in a loss of social welfare. Ferguson (1974) defines a barrier to entry as "factors that make entry unprofitable, while permitting established firms to set prices above marginal cost, and to persistently earn monopoly profits" (p. 10). He, therefore, adds another aspect to Bain's definition: the exercise of market power. Gilbert (1989) defines a barrier to entry as a rent that is derived from incumbency. He states that entry barriers exist only if the profit that an incumbent firm is earning is greater than what it would earn if we were to transfer its capital into the next best alternative use. In his definition, therefore, the emphasis is on the advantage of incumbency, rather than the disadvantages related to entry.

Geroski (1991c) argues that different views about the nature of barriers facing entrants depend on different ideas about the reason for the observed turnover occurring in an industry. If entry is just a 'hit and run' process, in which entrants take their chance in the markets, then there is no stable long-run equilibrium market structure involving a fixed number of incumbents, protected from outsiders by certain characteristics of the environment. However, if entry is considered as a process of trial and error in which entrants evaluate their abilities and cannot survive, unless they prove their superiority, then entry barriers are a set of skills that must be mastered or some scarce assets that must be obtained, in order to make entry profitable. In this case, entrants have to incur a certain amount of costs to reach a level of output that makes them profitable in the long-run. Once that is reached, no further expenditure is necessary.

Despite the controversy over the definition of entry barrier, they have been divided into two major sub-categories in the literature: structural entry barriers and behavioural entry barriers.

2.2.2.2.1 Structural entry barriers

Bain (1956) introduced structural entry barriers as the deterministic components of the condition of entry and market structure. According to him, the absolute cost advantage of established firms, economies of scale and product differentiation are three major structural characteristics that determine the overall height of entry barriers and, subsequently, the condition of entry. Therefore, these three main sources together with the extent of multi-plant operation in an industry are explained, in the following paragraphs, as the major structural entry barriers.

Absolute cost advantage of incumbent firms: Bain (1956) states that "an absolute cost advantage exists if the prospective unit costs of production of potential entrant firms are generally, and more or less at any common scale of operations, higher than those of established firms" (p. 144). According to Bain, the principal potential sources of the absolute cost advantage, on the side of the incumbent firms, are as follows: 1) if incumbent firms have superior production techniques and, therefore, are able to either deny their use to entrants or charge them for their use, which in both cases will raise the entrants' cost. The control of techniques is also possible through patents and secrecy; 2) if incumbents can obtain factors of production, especially capital, on more favourable terms than entrants; and 3) strategic factor supplies, such as natural-resource raw materials, might be owned or controlled by incumbents, so that entrants are denied access, or have to use inferior materials or purchase these materials from incumbents at a premium price. Bain states that these asymmetries result in barriers being higher for entrants.

Weizsacker (1980) has a different view regarding the sources of absolute cost advantage. According to him, not all the sources introduced by Bain are entry barriers. Superior efficiency and lower cost supplies of natural resources are differential rents, which are compatible with perfect competition and optimal allocation of the resources; they are therefore not entry barriers. On the other hand, cost advantages that are associated with a monopoly position are a barrier, as in this case the supply of output is restricted compared to the social optimum. However, if the restriction of supply and price above cost is an incentive for greater technical progress, then it is not a barrier.

Capital cost advantage, according to Yip (1982), can be a barrier in itself. Bain (1956) mentioned that having peripheral access to factors of production, especially capital, could create post-entry cost asymmetries between entrants and incumbents. However, Baumol and Willig (1981) showed that capital expenditure could be a barrier, only if the expenditure is sunk, as it cannot be recovered in the case of an unsuccessful entry. On the other hand, fixed costs of entry do not constitute a barrier. Eaton and Lipsey (1980) identified capital durability, as a source for sunk costs, while Mata (1991) introduced capital specificity as another source. According to Mata, specificity of capital is a source for sunk costs, as once it takes a specific form it is costly to be transferred to another use. On the other hand, durability of capital is a source for sunk costs as once resources are committed to durable capital in a particular form, they have to operate until the end of the capital's life, in order for their cost to be recovered.

The following studies found that capital requirement had a negative impact on entry: Orr (1974), Khemani and Shapiro (1986), Chappell *et al.* (1990), Kessides (1990) and Dunne and Roberts (1991). Using data from 36 countries, Gschwandtner and Lambson

(2002) found that industries with a higher level of sunk costs had significantly lower number of entrants. However, Highfield and Smiley (1987) found no such significant impact. Gorecki (1975) found that only domestic entrants are deterred from entry into industries with high capital intensity. Khemani and Shapiro (1988) and Mata (1993) both observed that capital had a negative impact on entry by de-novo firms. Acs and Audretsch (1989b) found that capital requirements have a negative impact only on the entry of smaller size entrants, while Acs and Audretsch (1989a) found that capital expenditure had no significant impact on the entry of either group of entrants of different size.

Economies of large scale: Bain (1956) introduced economies of scale as another major source for entry barriers. He argued that if the Minimum Efficient Scale (MES) in a market is relatively large, compared to the total size of the market, then entrants may expect higher than average costs, if they enter below MES, or lower prices post-entry, if they enter at the MES level. In this case, established firms are able to raise their prices above the minimum average cost, without attracting entry. The degree that incumbents can elevate their prices above minimum average costs is the extent of the barrier to entry created through the existence of economies of scale. Ferguson (1974) explains that some inputs are available only in 'lumpy units'. Therefore, entrants have to incur these costs if they want to produce at any level of output greater than zero. This might cause their average cost curve to lie to the right of the demand curve, at any level of output, making entry unprofitable, while incumbents are exercising market power or even enjoying super-normal profits.

Whether or not economies of scale create a barrier to entry has caused controversy. Stigler (1968) defines an entry barrier as "a cost of production (at some or every rate of output) that must be borne by a firm which seeks to enter an industry, but is not borne by firms already in the industry" (p. 67). According to him, barriers exist only if there is a post-entry asymmetry in costs between entrants and incumbents. Once entrants have invested in an efficient plant there will be no difference in costs post-entry, and without such a difference there is no real barrier to entry.

In the model introduced by Dixit (1980), established firms choose a pre-entry level of capacity in order to deter entry, although they do not employ threats that they will not rationally execute. Schmalensee (1981) built on the model of Dixit and showed that if a threat is credible and demand is concave, then the pre-entry present value of the excess monopoly profits that can be shielded from entry does not exceed even 1% (due to the existence of economies of scale). Therefore, he concluded that the degree of barriers created through existence of economies of scale is generally unimportant. However, Schmalensee explained that economies of scale could become a significant barrier if: 1) products are more differentiated, or markets are regional rather than national. In these cases, competition becomes more localized, therefore as the size of the markets reduces, this results in an increase in the MES relative to the total size of the market; and 2) economies of scale in advertising are important. Perrakis and Warskett (1986) extended the model of Schmalensee but assume that demand is uncertain, due to the normal business cycle. In their model, the upper boundary on profits, introduced in Schmalensee's model, no longer holds. The larger the MES relative to the total size of the market, the more the upper boundary is shifted upwards. Therefore, they support Schmalensee's results that economies of scale are a barrier, but not his conclusion that economies of scale produce unimportant barriers.

Various empirical studies have found economies of scale to be an important barrier to entry (Harris, 1976; Hause and Du Rietz, 1984; Khemani and Shapiro, 1986; Mayer and

Chappell, 1992). However, Highfield and Smiley (1987) did not find any significant impact of scale economies on entry. Similarly, looking at entry by plant creation versus plant acquisition, Baldwin and Gorecki (1987) did not find any significant impact of economies of scale on both of these categories. Mata (1993) found that the presence of economies of scale in an industry affected de-novo, extension and expansion entry negatively. However, the impact on purely diversifying entry was positive. Khemani and Shapiro (1988) found that the only category of entrants that responded negatively to economies of scale was the de-novo entrants (although reasons for this were not discussed by the authors).

Product differentiation advantage: The third major source of structural entry barriers, according to Bain (1956), is a product differentiation advantage on the side of incumbents. He explains that "buyers may have a preference, transitory or permanent, for some or all established products, as compared to new-entrant products, and this may in essence create some barrier to entry" (p. 114). He further explains that as a result of product differentiation sellers have some authority over their prices. Therefore, they can raise their price without losing all the customers, or decrease their price without attracting all the buyers away from substitute products. Consumer's preferences over the established products might place new entrants at a disadvantage when compared with the established firms. In this case, new entrants might have to tolerate lower prices or higher costs, compared to other established brands, until their brand or product gains consumers' acceptance.

At this point, one might ask the question why entrants cannot produce the same product as incumbents. According to Church and Ware (2000), there are two reasons that precludes entrants from doing so: 1) legal impediments and asymmetries of information regarding product quality or characteristics; and 2) fixed costs of entry and price competition post-entry. Church and Ware explain that the lack of information about quality, character and the attributes of the products, gives an important weight to any mechanism that allow entrants to obtain information. Legal impediments (like trademarks) provide consumers with such information. In addition, trademarks stop others from copying a firm's product; make it possible for consumers to differentiate between different products; and create incentives for firms to differentiate and maintain reputation and create brand loyalty. At the same time, the existence of product differentiation can create a barrier to entry, by reducing the size of the market and therefore enhancing the effect of economies of scale. In this case, the existence of products that appeal to consumers, due to their characteristics, or products that have high cross-elasticity of demand with the entrant's product, can create an entry barrier. In the first case, it is due to the limited market niches available, which makes entry unprofitable, and in the second case it is due to the presence of post-entry price competition.

With regard to the empirical literature that looks at the effect of product differentiation on entry, advertising has been used mainly as a proxy for the degree of product differentiation. Comanor and Wilson (1967) believe that advertising is both a source and a symptom of product differentiation. However, it has been argued that this is a poor proxy and it can have a dubious effect on entry. Nelson (1970) shows that creating product differentiation and decreasing cross elasticity of demand is one possible effect of advertising. However, advertising can be informative and acquaint consumers about alternative products in the market and so can be an inducement to entry. The empirical work in this area will be explained in Section 2.2.2.3, which looks at the effect of advertising on entry.

Multi-plant operation: According to Duetsch (1984), the existence of multi-plant firms affects entry in two possible ways: 1) if the average cost of a multi-plant firm is lower than that of a single-plant firm, then entrants would suffer a cost disadvantage if they are to produce only one product line, or serve a single region. Looking at the effect of absolute cost advantage on entry, it was explained that raising the start-up capital in order to enter at the MES level is a barrier to entry. However, capital costs can be a more serious barrier, if it has to be raised in order to set up a multi-plant firm, as entering as a single-plant firm could place entrants in a disadvantaged position, compared to the multi-plant incumbents; and 2) even if multi-plant firms do not possess any potential cost advantage, potential entrants might fear a price reduction by multi-plant firms, in order to deter their entry into the market. Therefore, entry into a segment of the market or into a product line is considered riskier for entrants, as multi-plant firms might reduce their prices, be involved in more intense product promotion, or indulge in any other activity, in order to deter entry. The negative impact of multi-plant operations on entry has been found in Duetsch (1984) and Mayer and Chappell (1992). However, Khemani and Shapiro (1988) found that only de-novo entry is negatively affected by the existence of multi-plant operations in industries.

2.2.2.2.2 Behavioural (or Strategic) entry barriers

Salop (1979) classified entry barriers into two sub-groups: innocent entry barriers, which are a result of innocent profit maximisation by incumbents, and strategic entry barriers, which are specifically erected to reduce entry. Church and Ware (2000) explain that the profitability of entry depends on the nature of competition post-entry and, therefore, on the behaviour of the incumbents. As a result, the pre-entry behaviour of incumbents can increase the height of entry barriers or reduce the profitability of entry.

Geroski (1995) argued that the immediate response of incumbents to entry is selective and they do not deter all kinds of entry. The reason is that entry deterring activities are usually costly and survival is difficult for the majority of entrants who exit only a short time after entry. Therefore, incumbents invest on entry deterring activities only if the threat from the entrants is serious. The two major behavioural barriers used by the incumbents are binding commitments and limit pricing, which will be explained next in this section.

Binding commitments: Bain introduced the notion of limit-price or, equivalently, limit-output, which was defined as the maximum level of price required to make entry unprofitable. His limit-price model was based on the assumption that entrants believe that incumbents will sustain their output level, even after entry occurs. Similarly, within a game theoretic framework, Sylos-Labini (1962) also postulated that entrants take the pre-entry level of output as a proxy for the post-entry level, and believe that incumbents will not increase their output post-entry. At the same time, established firms maintain this level of output, even after entry takes place. Both Bain and Sylos-Labini postulated that entrants believe that the established firms will maintain their level of output. However, as will be explained shortly, this assumption is not valid, unless one brings the notion of binding commitments into it. Binding commitments by the established firms generally guarantee negative post-entry profit for the entrant.

The notion of threat and commitment was introduced by Schelling (1960): "...commitment is a strategic move, a move that induces the other player to choose in one's favour. It constrains the other player's choice, by affecting his expectations" (p. 122). He further explained that "like the ordinary commitment, the threat is a surrender of choice...the threat and the commitment are both motivated by the possibility that a rational second player can be constrained, by his knowledge that the first player has altered his own incentive structure. Like an ordinary commitment, a threat can constrain the other player only insofar as it carries to the other player at least some appearance of obligation" (p. 123). Salop (1979) explained that established firms might possess a pre-entry asymmetry advantage, as they have committed resources before entrants. This gives them a first mover advantage which creates a fundamental base for them to strategically deter entry. As a result, established firms are able to choose a level of capacity or commitment before entry takes place. One of the predominant binding commitment strategies that is used is the creation of excess capacity.

Needham (1969) showed that the assumption that Sylos-Labini (1962) made might not hold and the monopolist, post-entry, might increase its level of output. In this case the monopolist can use excess capacity in order to intimidate entrants and make them believe that the output level is going to be increased post-entry. At the same time, if entrants believe that the post-entry output level of the monopolist is equal to its pre-entry capacity then entry can be deterred. Needham proposed a new limit price level as the highest pre-entry price that makes entry unprofitable, after taking account of both the monopolist and the entrant's reaction. However, in this case entry is deterred only if entrants believe that the monopolist is going to increase its output.

Spence (1977) applied the concept of advanced commitment and argued that investing in excess capacity is a barrier to entry, partly because it is irreversible and presents a pre-emptive commitment to the industry. In this case, entry is deterred only if existing firms have enough capacity to make entry unprofitable. Dixit (1980) in his model showed that the irrecoverable choice of investment (e.g. building excess capacity), by a monopolist can change its post-entry marginal cost and therefore the post-entry equilibrium. In this case, the monopolist can use this privilege to exercise limited leadership.

Von Ungern-Sternberg (1988) explored an alternative reason for holding excess capacity by a dominant firm, to maintain its economic relation with other upstream (or downstream) companies. He explained that companies usually have to invest a certain amount of specific sunk cost into their relationship with the dominant firm. However, before making any commitments, they need some kind of guarantee from the dominant firm to make sure that it is not going to act opportunistically, when these costs are incurred. By acting opportunistically, Von Ungern-Sternberg meant that the established firms would not suddenly decrease their demands (or their supplies) at given prices. In this case, investment in creating excess capacity can be an effective means of giving the upstream (or downstream) firms the assurance they require. In terms of empirical work, Hilke (1984) and Mathis and Koscianski (1996) found a negative impact of excess capacity on entry.

Limit pricing: Gaskins (1971) explained that limit pricing is exercised when the incumbents keep prices at such a low level that the entrants' profitability, post-entry, falls below their opportunity costs. However, Geroski *et al.* (1990) explained that limit pricing can be exercised only when entrants believe that the incumbents are not going to maximise their short-run profit. In terms of the empirical work, both Hannan (1979) and Masson and Shannan (1986) found that in their sample limit pricing was used in order to deter entry. However, Smiley (1988) found no such evidence.

2.2.2.3 Inducements or impediments to entry

Advertising intensity: Generally there is a lack of consensus over the anti-competitive effects of advertising, in both the empirical and the theoretical literature. The issue is whether there is a mechanism in which firms can exercise market power through advertising. Bain (1956) introduced advertising expenditure as a source for product differentiation. He stated that "product differentiation is by differences in the design or physical quality of competing products, by efforts of the sellers to distinguish their products through packaging, branding, and the offering of auxiliary services to buyers, and by advertising and sales promotional efforts" (p. 114). Behind Bain's theory there was an asymmetry regarding the response of consumers to advertising efforts by established firms and new entrants that was not explained. Schmalensee (1974) suggested that the main source of asymmetry is 'product appeal and promotional skills' of the incumbents. If new entrants are able to produce equally effective advertising and equally desirable products, then there is no difference between the established firms and entrants, in the marginal effect of their advertising. According to Schmalensee, the main reason for the anti-competitive effects of advertising is demand asymmetries. However, Comanor and Wilson (1974) referred to the effect of experience of consumers with the established product and the rewards from past advertising, as other reasons for the asymmetric effects of advertising for established firms and new entrants. They explained that the degree of experience that consumers have with a specific product causes differential responses to advertising by established firms and new entrants.

On the other hand, Nelson (1970) looked at the effect of advertising on the cross elasticity of demand. He explained that adverting is a way of conveying information to the consumers and therefore increasing their knowledge about the existence of alternative products. This means that advertising can increase the cross elasticity of demand. Schmalensee (1976) in his model found that advertising neither raises entry barriers nor facilitates collusion.

The empirical work regarding the effect of advertising on entry is also controversial. Hirschey (1981) and Duetsch (1984) found no significant impact of advertising on entry. On the other hand, Orr (1974), Duetsch (1975), Khemani and Shapiro (1986), Chappell *et al.* (1990) and Rosenbaum (1993) found that advertising had a negative impact on entry. In terms of the effect of advertising on different groups of entrants, Gorecki (1975) found a negative impact of advertising only on entry by domestic firms; Khemani and Shapiro (1988) found that advertising had a negative impact on entry by de-novo firms and already existing firms entering the same industry. However, Mata (1993) found a positive impact of advertising on expansion entry and a negative impact on purely diversifying entry.

R&D intensity: The impact of research and development (R&D) activities on entry has also been a subject of controversy, both in theoretical and empirical work. Mueller and Tilton (1969) explained that R&D could constitute a barrier to entry. According to them, the R&D barrier has two chief components: the first component is "the extent of economies of scale in the R&D process" and the second component is "the accumulation of patents and know-how on the part of incumbent firms" (p. 578). At the same time, Acs and Audretsch (1989b) argued that small firms in highly R&D intensive industries are able to compensate for their size disadvantage, by the strategy of product innovation and by carving out a niche for themselves. Therefore, R&D intensive industries could facilitate the entry of small firms.

Among those who have produced empirical studies on the R&D effect on entry are: Orr (1974), who found that it had a negative impact on entry; Baldwin and Gorecki

(1987), who also found that R&D had a negative impact, but only on entry through plant creation; Gorecki (1975), who found that only domestic entrants were negatively affected by R&D intensity; and Mata (1993), who found that R&D had a negative impact on entry of both de-novo and diversifying entrants. On the other hand, Highfield and Smiley (1987) found R&D had a positive impact on entry; while Acs and Audretsch (1989a) found that high R&D intensity, in the industries in their sample, encourages both entry by small and large firms. On the contrary, Shapiro and Khemani (1987) did not find any significant impact of R&D on entry. Clearly the evidence is very mixed.

Concentration: Seller concentration has been found to have two contrary effects on entry. Yip (1982) argued that high seller concentration could thwart entry, as the possibility for oligopolistic coordination is higher in highly concentrated industries. On the other hand, it might form an inducement if entrants survive the reaction barrier posed by incumbents and subsequently enjoy a less competitive and more protected environment. He concluded that whether concentration acts as a barrier or as an inducement to entry depends on the entrants' resources, compared to those of incumbents. For weak entrants, the reaction effect can outweigh the inducement effect, while for the stronger entrants it may have the opposite effect.

Orr (1974), Chappell *et al.* (1990) and Mayer and Chappell (1992) found a negative impact on entry by seller concentration. Khemani and Shapiro (1988) also found a negative impact of concentration, but only on de-novo entry. On the other hand, Duetsch (1975) and Harris (1976) found that concentration had a positive impact on entry.

2.2.2.4 The impact of the industry life cycle

Gort and Klepper (1982) explored how markets evolve through the various stages of their life cycle. According to them, when a product is first introduced there is a large amount of external information available, which motivates new firms to enter the market and exploit it. As the number of entrants increases, prices are reduced and subsequently output increases. At the same time the incumbents' knowledge tends to replace external knowledge. This pushes the most inefficient firms out of the industry, leaving net entry to reduce over time. Agarwal (1998) tested this theory and found that this pattern existed across a wide range of products. He found that as a result of this evolutionary pattern, the attributes of the markets, in terms of availability of information, innovative activity and structural characteristics tend to change, as they go through various stages.

Hoff (1997) focused on the role of imperfect information, as a barrier to entry into infant industries. He explained that early entrants take more risk, in the sense that they are accessing a market that no other firm has experienced before. As markets evolve, due to the success or failure of the early entrants, more realistic information becomes available to the new entrants. Therefore, according to Hoff, the basic source of asymmetry is a learning spill over which substantially varies for early and late entrants. Horvath *et al.* (2001) explained that in the early stage of the industry's life cycle entry is delayed, as potential entrants are accumulating information. Subsequently, due to observing the performance of incumbents, new entrants with increased knowledge are encouraged to participate in the market.

Besides the availability of information, the nature of innovative activities also tends to vary in the various phases of the industry's life cycle. With special reference to the technologically progressive industries Klepper (1996) showed how the nature of innovative activities varies as an industry matures. He explained that upon the birth of a new industry a large amount of entry takes place, and the rate of product innovation is high and firms' shares in the market vary rapidly. As the market matures, the rate of entry decreases, due to the emergence of a dominant design, and innovative activity takes on the form of improvement through process innovation. As a result, the number of firms decreases and the rate and diversity of product innovation ultimately declines. Following the same line of argument, Jovanovic and MacDonald (1994) explain that the main reason behind the non-monotonic trend in the number of firms (first increasing and then decreasing) is the changes in the nature of innovative activities across the two stages. In the first stage, innovation fuels entry, while in the second stage entrants fail to innovate and therefore exit.

McGahan and Silverman (2001) showed that in the mature phase of the industry's life cycle, there was no evidence that there is a shift from product to process innovation. However, they showed that in the mature phase industry's leaders are more engaged in diversifying and reinvesting in innovations. Geroski and Mazzucato (2001) showed that the shift in innovative activities is accompanied by an increasing level of concentration. They explained that along side the decrease in population size market size also increases, which shows a positive association between concentration and market size.

In general, the models described above show that from the formative to the mature stage of the industry's life cycle substantial changes occurs to the structural characteristics of markets. Agarwal and Gort (1996) explained that the observed structural changes in industries, as they go through the various stages of their life cycle, effect entry of new firms in two distinct ways. On the one hand, it changes the value of the explanatory variables, such as the attributes of the industry, while at the same time it changes the value of the parameters that relate entry to the explanatory variables. In addition, Agarwal and Gort showed that the presumed positive correlation between entry and exit depends on the stage of their life cycle. By dividing the life cycle into five different stages they found that the positive association between entry and exit exists only in the second stage of the life cycle. Based on these differences, one might also expect significant differences in the type of entrants and their motives across the different stages of the industry life cycle.

2.2.3 Geographical specific factors

Geographical specific factors relate directly to the characteristics of the area in which the new firm is going to be established. The combination of a wide range of factors could make an area either an attractive location for investment or make it unprofitable. Keeble *et al.* (1993) provided a review of the literature in relation to the factors that cause differences in entry rates, across different geographical areas. In this section, a review of these factors will be provided.

High demand in the local market: As firms usually tend to serve local markets their profitability can be directly related to local demand. In this case, a measure of potential demand, or the wealth of residents, can be a good indicator of a firms' future demand (Storey, 1982). Fritsch (1992) and Armington and Acs (2002) both found that high demand in the local market had a positive impact on the rate of formation of new firms. However, Berglund and Brannas (2001) found the effect of average income (a proxy for local demand) on entry of new manufacturing plants into the Swedish municipalities to be insignificant. In terms of the impact of demand in local market on foreign entry, Friedman *et al.* (1992) and Billington (1999) both found that the size of the host market had a positive impact on foreign direct investment decisions. However, Scaperlanda and Mauer's (1969) found no such significant impact.

Wealth of the individuals in the area: Start-up capital is the primary requirement to start a new business. Entrepreneurs can either provide the required capital themselves or they can borrow it. In any case, the higher the wealth of the residents in the area, the easier it is to provide start-up capital (Reynolds *et al.*, 1994). Individual wealth in the local area is usually measured by the extent of house ownership. However, the effect of house ownership on firm formation can operate through two channels: a demand and a supply channel. The extent of home ownership can proxy future demand in the local market and/or it can be indicative of the extent of capital availability in the area. In the latter case, individuals might use their house ownership as collateral, in order to finance a new business and borrow the start-up capital (Storey, 1982 and Cross, 1981). Fotopoulos and Spence (1999) found that personal wealth at the local level had a positive impact on new firm formation.

Existence of external economies of scale in the area: Based on the theory introduced by Krugman (1991a, 1991b), there can be a positive association between the existence of external economies of scale within a geographical boundary and the likelihood of new firm formation. In his theory, Krugman incorporated external economies of scale as an important factor that affected regional growth disparities. As one of the important sources for the regional growth disparities is the formation of new businesses, one can conclude that there is a positive association between the existence of external economies of scale and new firm formation.

According to Armstrong and Taylor (2000), external economies of scale arise from the geographical proximity of economic activities. They further explained that two sources contribute to the existence of external economies of scale: *localised economies* and *agglomeration (urbanization) economies*. The spatial concentration of related economic activities provides firms with the opportunity to take advantage of *localised economies*. An extreme scenario is when plants all belong to the same industry, which results in a localised industry. Firms find it profitable to build up their production facilities within a short distance of both suppliers and consumers as it facilitates any input-output exchanges. On the other hand, specialisation of an area happens when it is dominated by a particular industry or industries. However, according to Fotopoulos and Spence (1999) it is important to note that although a specialised area could result in a localised industry, the opposite does not necessarily have to be true. A localised industry could exist within a well-diversified area.

Krugman (1991b) showed that manufacturing firms intend to take advantage of internal economies of scale, and so minimise their transportation costs. At the same time, they try to concentrate in those areas that have the larger demand. He also elaborated on Marshall's view on why firms localise: 1) localisation results in a highly specialised pooled labour market. This increases specialisation in the area, which results in higher productivity at the level of individual firms; 2) localization improves the production of the non-tradable specialised inputs. The reason is that when the production of an intermediate input is highly localised, it allows a larger number of small firms to produce it, rather than a few large firms. This results, subsequently, in the production of a more diversified intermediate input, at a lower cost; and 3) localization reduces information asymmetries, through the increase in technological spill-overs, as a result of knowledge spilling over from high technology firms, and movements of highly skilled workers between companies.

Audretsch and Feldman (1996) and Anselin *et al.* (1997) studied the relationship between knowledge spill over and innovative activity. Audretsch and Feldman found that, after controlling for the concentration of production, innovation was more concentrated in those regions with a higher level of knowledge spill over (through industry R&D), university research and skilled labour movements. Anselin *et al.* also found that across the US differences in university research had a positive impact on the innovative capacity of different States.

In addition to the three reasons proposed by Krugman, Armstrong and Taylor (2000) referred to another reason for localization: a high level of job security for both employers and workers in the region (although this might be seen as a natural outcome of the pooled labour market). In case of losing their job, highly specialised workers could easily be employed in other firms and their knowledge is easily transferred to other companies. At the same time, employers face a larger population of skilled workers in the supply market from which to choose labour.

Considering all the advantages discussed above, in relation to the localization of the industries or specialisation of the areas, one would expect a higher rate of entry in areas with a large number of plants belonging to the same industry. Garofoli (1994) and Fotopoulos and Spence (1999) both found that area specialization had a positive impact on new firm formation. However, with similarly convincing reasons, Gudgin (1978) argues that diversification in the area has a positive impact on the rate of firm formation. He explains that a high level of diversification in an area shows the variety of skills needed. This attracts a labour force having a wide range of knowledge and abilities and gives rise to new firm formation. At the same time, it makes sure that any increase in demand will be exploited locally.

The second source of external economies of scale is *agglomeration economies*. Henderson (1986) explained that an agglomeration (or density) effect is a result of the geographical concentration of a large number of economic activities. Therefore, it differs from localised economies in that it measures the degree of industrial concentration in an area across industries, rather than within industries. Armstrong and Taylor (2000) explain that agglomeration economies could result in a high concentration of facilities serving various industries. These facilities include: transport and commuting facilities; a large pool of labour with diversified skills; the provision of government services; legal and commercial services; market oriented activities; cultural and recreational activities and the clustering of organizations that invest highly in process and product innovation. Therefore, one would expect such regions to be attractive for those in pursuit of a good environment to start a new venture. Armington and Acs (2002) measured agglomeration economies by industrial density and found that it had a positive impact on entry. On the contrary, Guimaraes *et al.* (1998) found in their sample that new firm formation was affected negatively by the population density of an area (a proxy for the degree of agglomeration economies). The reason suggested was that a high density in an area indicates a high level of congestion, which can offset the positive effects of agglomeration economies on new firm formation. Dumais *et al.* (1997) also found that new firms preferred less concentrated regions. In terms of the impact of density on foreign entry, Billington (1999) found that it had a negative impact on foreign direct investments in the UK.

Size structure of the areas factories: Small firms have been found to be a better incubator for potential new firms than large firms (Cross, 1981). The major reason for this effect is that working for a small firm provides the opportunity for employees to familiarise themselves with a wide range of operational processes (Storey, 1982). As a result, they can obtain a wide range of task experience and have closer contact with the managers or the directors of the company, which also increases their confidence (Lloyd and Mason, 1984; Mason, 1991). Another reason, according to Storey (1982), is that job security is lower in small firms and therefore the fear of redundancy could trigger employees to set up their own businesses. Johnson and Cathcard (1979) referred to the pre-selection of companies by potential founders and discovered that they tended to choose smaller plants, which would give them a wide spectrum of experiences required for being an entrepreneur. However, less entrepreneurially minded workers choose larger companies, due to their higher job security. Various studies have found that regions with a large number of small plants have a higher rate of new firm formation than regions dominated by large plants (Fritsch, 1992; Garofoli, 1994; Fotopoulos and Spence, 1999).

Occupational structure of the residents in an area: The likelihood of starting a new business is affected by an individual's skill level and experience (O'Farrel, 1986). The lack of availability of human capital could be an entry barrier, which must be overcome in order to start any business. The more skilled the entrepreneur, the easier this barrier can be breached (Fritsch, 1992). The level of skilled workers in an area is both an attraction and a generating force for new firms (Lloyd and Mason, 1984). However, Storey (1982) argues that this factor, or the intellect of individuals, is a necessary but not a sufficient condition for stimulating firm generation. He explains that innovators usually work independently, while being a manager requires certain personal skills that they might not possess. The following studies have found that areas with high levels of skilled workers tend to have higher levels of firm formation: Fritsch (1992) and Keeble and Walker (1994).

Unemployment: An individual's decision to become an entrepreneur, or to stay in employment, depends on the earnings associated with each choice. If the expected earnings from being self-employed exceed that of being in employment (by a minimum threshold) then individuals go into self-employment (Creedy and Johnson, 1983). There are two conflicting hypothesis regarding the effect that unemployment has on new firm formation. Based on the recession (or push) effect, the shortage of alternative jobs in times of recession pushes individuals into starting their own businesses (Reynolds *et al.* 1994). On the contrary, high unemployment in an area can be indicative of the lack of buoyancy of demand and, therefore, discourages individuals from starting their own business (Storey, 1982).

In empirical work, unemployment has also been found to have a dubious effect on new firm formation (Fritsch, 1992; Garofolli, 1994; Guesnier, 1994; Reynolds *et al.*, 1994; Armington and Acs, 2002). In terms of the impact of unemployment on foreign entry, Friedman *et al.* (1992) and Billington (1999) both found that an area's unemployment had a positive impact on FDI. Based on a wide review of the empirical evidence, Storey (1991) found that, *ceteris paribus*, in time series analysis unemployment has usually had a positive impact on new firm formation, while in the cross section analysis it has had a negative impact. Reconciliation of these two conflicting effects has not been successful. Armington and Acs (2002) explain that industries with a low level of capital required for start-up face a high rate of firm formation when there is higher unemployment, while those industries that require a significant amount of start-up capital face the opposite. This shows that when studying the effect of unemployment on new firm formation, one has to take account of the structural differences across industries; otherwise regression results will potentially be biased.

The North-South division: A greater decline in manufacturing employment in the northern regions of the UK during the early 1980's was an important factor that contributed to the so-called 'North-South' divide. This caused inequality in industrial development and social well-being between the regions of the North and the South (Townsend, 1983). In the current study, the North includes the regions of the North, the North West, Yorkshire and Humberside, the West Midlands, Scotland, Wales and Northern Ireland; while the South includes the regions of the South East, the South West, East Anglia and the East Midlands. Various studies have found major differences between the regions of the North and South in a wide range of aspects, including regional growth, unemployment, rates of return on capital and new firm formation (Keeble and Walker, 1994; Martin, 1997; Harris and Andrew, 2000). These differences are a result of the socio-economic characteristics of the regions, which according to Gripaios *et al.* (2000) are based on industrial structure, population structure and the occupational structure of these regions. With a high proportion of employment being concentrated in traditional industries in the North, and in finance, the service sector and high technology industries in the South (especially the regions of South East and East Anglia), it is useful to make a distinction between them (as is done here in this study).

2.3 Exit

2.3.1 Plant specific factors

Country of ownership: Ownership status is expected to affect a plant's risk of closure. Caves (1996) explained that one of the reasons that firms expand across their national borders is to spread their business risk. The more they spread across their national borders and across product markets, the more successful they may be in spreading such risk. This also brings diversification gains for firms who are usually risk averse. Caves further explained that foreign investment could be particularly risky because: 1) national policies usually try to maximise national welfare and aim to remove monopoly profits from multi-national enterprises' (MNE) pockets and shift it towards domestic producers. Therefore, foreign investors can face a lack of support from the local government, which makes their investment riskier than that of domestic investors; and 2) the cost of obtaining information is always higher for foreign investors than for domestic investors. Even after investment in gathering information, MNEs have less knowledge than domestic producers regarding market conditions, consumers' taste and a variety of other factors. Based on this argument, one could expect that plants belonging to foreign enterprises are more prone to closure. Thus foreign enterprises when faced with any loss often prefer to close their overseas plants first.

In terms of empirical work regarding this effect, McCloughan and Stone (1998) found no significant impact of foreign ownership on the survival of plants in the northern regions of England. However, Colombo and Delmastro (2000) found that in the Italian metalworking industry foreign ownership had a significant positive impact on closure decisions.

Change in ownership: In order to explain the effects that a change of ownership has on the survival of plants, it is necessary to understand the possible reasons behind any acquisition decision. Within the neoclassical tradition, Mead (1968) proposed that the main reason behind any takeover is to increase the profitability of companies when they are not making sufficient profits. Therefore, if managers are not able to produce a product for which there is sufficient demand, or are not able to reduce their costs of production, or are sacrificing profits to finance their growth, then replacement of the old management by one which is more efficient and profit-minded could increase the value of the company's shares. In the same vein, Manne (1965) maintained that there is a positive association between managerial efficiency and prices of the company's shares. When a company is poorly managed and is not making enough returns for the shareholders, then the poor management has to be replaced.

The above theories basically assume that takeovers happen so that an inefficient plant can be turned around and achieve a better performance. This should therefore increase the life duration of an acquired plant. However, the empirical work tends to prove the opposite. Studying takeover decisions in the US in the 1960s and the 1970s Ravenscraft and Scherer (1987) and Matsusaka (1993) found that the target firms were extraordinary profitable, prior to being acquired, with no gain in profitability post-acquisition. Ravenscraft and Scherer (1989) also found that acquired small size plants, in their sample of the US plants over the 1957-77 period, were significantly more profitable pre-acquisition. Using the US Longitudinal Research Database (LRD), McGuckin and Nguyen (1995) found that, over the 1977-87 period, the target plants not only did not exhibit poor performance but also had a higher than average productivity. The majority of the acquired plants in their sample experienced improvements in productivity post-acquisition and for those that did not their productivity fell towards the industry's average, while still remaining above it. Therefore, they proposed that acquisitions are geared towards gaining operating efficiency, rather than improving management. Treating change in ownership as an exogenous variable, McGuckin and Nguyen (2001) found that plants that changed ownership had a higher probability of survival post-acquisition, relative to those that did not change ownership. However, once change in ownership was treated as an endogenous variable and the size and productivity of plant were taken into account (as a composite variable with change in ownership dummy), it had a positive impact on the risk of closure. This meant that change of ownership had a negative impact on the risk of closure of the larger and the more productive plants.

The above discussion on the impact of change of ownership ignores acquisitions by foreign companies. Foreign acquisition is considered a way of acquiring capacity in a host country. However, foreign firms have the choice of entering the host country either by setting up a new plant (greenfield entry) or by acquiring the already existing plants (brownfield entry). Caves (1996) explained that foreign entry, through acquisition, might possess some advantages over greenfield investment. The main reason is that by entry through acquisition, a foreign enterprise can rely on the pre-existing relationships with suppliers and consumers and also depend on the expertise of the existing personnel, who are familiar with local market conditions. Therefore, entry through acquisition is a low risk strategy for quick entry, in which the MNEs can benefit from the local ongoing management. However, greenfield entrants face more risk and are a slower mode of entry. Caves (*op. cit.*) pointed out one reason for choosing greenfield entry as the mode of entry, namely familiarity with the product line. Hennart and Park (1993) studied the mode of entry of Japanese firms when entering the US markets. They found that Japanese investors preferred greenfield entry, when they wanted to produce a product that they were already producing in their home market. In this case, they tended to choose more R&D intensive industries as they could transfer their technological advantages more efficiently. On the other hand, they entered through acquisition if the target industry was characterised either by high growth, or high concentration and low growth. The reason was that in the case of high growth it is a quicker way to enter and exploit profitable opportunities, while in the second case it would not add to the industry's capacity and therefore would not provoke a reaction from incumbents. Buckley and Casson (1998) compared various strategies for entering a foreign market and the situations in which a specific mode of entry becomes more favourable. They found that greenfield entry was more likely when entrants owned a specific type of technology but was less likely when the cost of buildings and also the cost of learning about the foreign market through experience was high.

McCloughan and Stone (1998) produced five reasons why entry through acquisition could have less chance of success, compared to greenfield entry: 1) acquisition is usually a complicated process, which imposes a variety of transactional and post-acquisition problems on the parent company. Therefore, there is always concern over the compatibility between the parent firm and the acquired plant (Besanko *et al.* 1996); 2) acquisitions are usually a means of reducing capacity in an industry; 3) managerial links between the parent company and the oversees subsidiaries tend to be stronger, when the mode of entry is greenfield (Li, 1995); 4) unlike the acquired plant, new plants are more likely to be equipped with the latest technologies; and 5) new plants can benefit from more financial aid from the host government in order to cover their fixed costs of construction, training and infrastructure modifications.

In terms of empirical work regarding these effects, McCloughan and Stone (1998) found that greenfield entrants faced significantly longer life duration than brownfield entrants. However, when they took account of the age of the acquired plants, the older plants that were taken over by foreign firms had longer life duration than the younger plants. Li (1995) looked at the survival of foreign plants in the US computer and pharmaceutical industry, during the 1974-89 period, and found that acquired entrants had a significantly higher probability of exit. Harris and Robinson (2002) looked at the performance of UK plants that were acquired by a foreign enterprise over the 1987-92 period. They found that foreign enterprises acquired the most productive plants, or in another words they 'cherry-picked' plants. They also found that plants that were acquired in this period were almost twice as productive as those plants that were not acquired. However, they found that the productivity of the acquired plants declined post-acquisition. The reason for this effect was the possible difficulties associated with the assimilation of the acquired plant into the new organization, which can reduce a plant's chances of survival.

Multi-unit versus single-unit plants: Models have been constructed that try to explain who exit first in a declining industry: multi-plant or single-plant firms. Reynolds (1988) showed that in a declining industry, large multi-plant firms close down their plants before smaller firms in order to reduce their capacity during industrial downturns without needing to totally close down. In such cases, the large multi-plant firms do so by first closing their highest cost branch plants. Ghemawat and Nalebuff (1990) also showed that in a declining industry large multi-plant firms are the first to reduce their capacity, due to their lower marginal revenue. In their model, which assumes continuous capacity adjustment, a unique sub-game perfect equilibrium exists, in which the largest of several equally efficient firms reduces its capacity until it reaches the market share of the next smaller firm. Baden-Fuller (1989) showed that a well-capitalised, diversified, multi-plant firm is more likely to close its branch plants than a single-plant firm, as it has a lower sunk cost of closure. The reason is that a multi-plant firm can re-deploy those factors of production, released due to closure of other plants, in the ongoing plants and stay in production without being have to incur re-entry sunk costs.

On the other hand, Whinston (1988) showed that the pattern of capacity reduction is not as simple to explain, as it depends on a variety of factors such as industry structure and market decline. Therefore, there might be a variety of situations in which large multi-plant firms are not necessarily the first to reduce their capacity.

Empirical work mainly supports the hypothesis that multi-unit plants are more likely to be closed, than single-unit plants. Baden-Fuller (1988) found that in the UK steel-casting industry the majority of plants that were closed between 1979 and 1983 belonged to multi-plant enterprises. Colombo and Delmastro (2000) also found that plant closure had a direct relation with multi-plant status since for a multi-plant firm plant closure neither means exit from the product market nor dissolution of the firm. Similarly, Audretsch and Mahmood (1995) and Mata *et al.* (1995) found that single-plant de-novo firms had less likelihood of failure.

On the other hand, Audretsch (1994) found that before taking account of the size of the plants belonging to a multi-plant enterprise, single-plant units were more likely to be closed than multi-plant units. This was due to the fact that multi-plant units had a higher start-up size than single-plant units. However, once the size of the plants was controlled, multi-plant units had a higher probability of closure. Therefore, the associated negative impact could be due to the discrepancy in the start-up size of the multi-unit plants relative to the single-unit plants, rather than their ownership status. Disney *et al.* (1999) found that age was also an important factor in determining the likelihood of closure of multi-unit and single-unit plants. In their study, young single-unit plants were more likely to survive initially but after a year they were less likely to do so. Looking at the closures implemented by UK multi-locational firms, Watts and Kirkham (1999) found that certain characteristics of plants like size and location (in terms of distance from the head office and other plants) significantly affected the closure decision. In this vein, Dunne *et al.* (1989) found that in US manufacturing between 1967 and 1982, small plants belonging to a multi-plant firm were more likely to be closed than small single-plant units, although it was the opposite for large plants. Therefore, one can conclude that the size of a multi-plant unit is also a deterministic factor in its closure decision.

Start-up size, current size and age: In the model developed by Jovanovic (1982), which was called the 'noisy' selection model, firms enter an industry without knowing the value of the parameters that determine the distribution of their profits. This means that they are unaware of their ability to compete effectively and initially face a cost disadvantage, as they usually enter below minimum efficient scale. As they continue operating, if they are efficient, they can grow and survive, otherwise they decline and fail. Ericson and Pakes (1995) modified this model and allowed for firms to learn about the value of the parameters that determined their profitability. An important parameter was their ability to compete, which could be improved by investing.

The implication of the above models is that the more firms grow from their initial size and the longer they stay in operation, the higher is their chance of survival in the longer run. Geroski (1995) represents this as a stylised fact that "both firm size and age are correlated with the survival of entrants" (p. 434). He further explained that turnover and exit are the by-products of a process in which firms adjust themselves to the turbulent environment, through information acquisition. At the same time, not only is information costly and some entrants under-invest in information gathering, but also in the presence of a changing market environment the type of action that they need to take in order to survive also changes. This clearly shows that the ability of entrants in learning about their changing environment directly affects their growth and, consequently, their survival. Therefore, the slower their process of learning, the more likely they are to decline in size and eventually exit. At the same time, as learning comes with age, the latter has an impact on growth and survival.

Based on the theory of strategic niches for small firms, suggested by Porter (1979), growth in not a necessary condition for the survival of small firms. Small firms can stay small and still survive, as long as they can find a strategic niche in the market in which to operate. Based on the theoretical and empirical work of Dhawan (2001), small firms in US manufacturing over the 1970-89 period faced a higher risk of closure due to uncertainties in the market and problems associated with raising capital. However, they were more efficient due to their simple hierarchical decision making structure, allowing them to find market niches to operate in. Agarwal and Audretsch (2001) reconciled the two views, regarding the impact of size and growth on survival. They contended that the relationship between size and risk varies under different technological conditions and also across different stages of the industries' life cycle. In technology intensive industries and in mature stages of the life cycle, the positive relationship between size and survival might not hold. The reason is that in the mature stages of the life cycle in technology intensive industries entry is more about filling market niches rather than radical changes, which to a large extent can offset the positive effect of size on survival.

Among those who have produced empirical work on this subject, the following have found that size and age have a positive impact on survival: Dunne *et al.* (1989), Audretsch (1994), Mata and Portugal (1994), Audretsch and Mahmood (1995), Boeri and Bellman (1995) and Doms *et al.* (1995). Mata *et al.* (1995) found that initial size had a positive impact and current size a negative impact on a plant's closure. The reason for this effect, according to them, was that small plants that managed to survive grew faster than large plants, which resulted in positive associations between initial size and closure. In any case, the more a plant grew from its initial size, the lower was its chance of closure. Disney *et al.* (1999) looked at the effect of initial size and current size, in conjunction with the age of plants. They found that initial size positively affected closure, while current size negatively affected it. However, a higher growth from the initial size had a negative impact on closure. After taking account of the age of plants, they found that initial size had less impact on closures. However, the negative association between growth and closure grew stronger with the age of plants.

Exit barriers: According to Caves and Porter (1976) these affect the behaviour of firms because they persistently impose sub-normal profits. The major sources of exit barriers, according to them, are durable and specific assets (DSAs) that might be attached to a particular company, productive activity or combination of both. They further divided the DSAs into *tangible fixed assets, intangible fixed assets*, *joint production* and *managerial behaviour*. *Tangible* DSAs were defined as physical inputs (like capital) or non-physical inputs (like a specialised labour force) that are attached to a firm, due to either being specific to a productive activity or due to a non-terminable long contract for the life of that asset. On the other hand, *intangible* DSAs are those that can be traded through franchising arrangements or the sale of trademarks. The effect of DSAs on firm behaviour can also be through *jointness in production.* This occurs when physical productivity of an input depends on its joint use with other inputs. Finally, *managerial behaviour* can also be a source for DSAs, when the specific skills of a manager have less value elsewhere. Between the sources of DSAs proposed by Caves and Porter *(op. cit.),* tangible fixed assets have been subject to most attention, in the theoretical and empirical literature. Eaton and Lipsey (1980) identified capital durability as a major source for sunk costs. Mata (1991) also referred to capital durability and specificity as the sources for sunk costs. He explained that capital specificity creates sunk costs, because once capital is committed to a specific use it is difficult to be transferred to another use. Capital durability is also another source, because firms must operate until the end of the capital's life. Dixit (1989) showed that the sunk component of the costs creates a barrier for both the entry and exit of firms. In this case, firms think longer before they commit resources and once they enter, in case of any losses, they wait longer before they exit. Within a game theoretic framework Garella and Richelle (1999) showed that the existence of sunk costs affects both the size and composition of industries. In the absence of re-entry costs, which are mainly sunk costs, the firm with the larger average cost is the first one to exit. However, if re-entry turns out to be unprofitable, due to the existence of re-entry costs, the one with a smaller average cost exits first. In terms of empirical work, Colombo and Demlastro (2001) found that the effect of advance technologies on firm survival depends on the characteristics of those technologies. However, *ceteris paribus,* plants that are employing sizable product specific technologies are less likely to close. Audretsch (1994) and Doms *et al.* (1995) both found that sunk costs had a negative impact on plant closure.

Profitability, productivity or efficiency of firms: According to Hudson (1990) the main reason for exit is unprofitability. Even in the case when future expected profits are positive, if liquidity falls below zero firms cannot survive long enough to realise the net positive future profits. Cuthbertson and Hudson (1996) showed that compulsory liquidations were mainly the result of low profitability, due to an increase in labour costs or costs of material inputs. Amongst the early empirical studies, Dunne and Roberts

(1991) and Mayer and Chappell (1992) were among the only studies that found a negative impact of price-cost margins on exit. However, these were found to be insignificant by Boeri and Bellmann (1995) and Kleijweg and Lever (1996).

Evans and Siegfried (1992) found that direct measures of profitability, like price-cost margins, are not significantly correlated with exit. The reason is that they are highly correlated with the magnitude of sunk costs. Therefore, a better estimator in this case seems to be either total factor productivity or efficiency. In a study by Oulton (2000) for UK manufacturing plants over the 1973-89 period, he showed that plants that were closed had lower productivity than survivors. Aw *et al.* (2001) also found that in Taiwanese manufacturing over the 1981-91 period, firms that exited were less productive than survivors. Similar results were found by Doms *et al.* (1995), which led them to conclude that firms close their less productive (or less efficient) plants first.

2.3.2 Owner-enterprise specific factors

Size of the multi-plant firms: It is important to note that the decision to close a certain multi-unit plant is not only affected by certain characteristics of the plant, but also by the characteristics of the owner enterprise. In relation to this, Liberman (1990) found that after controlling for the size of plants, their probability of closure increased as the owner firm's capacity share of the industry increased. The reason was that, *ceteris paribus*, large firms cut capacity by a greater percentage than small firms. Chen (2002) argued that the chances of closure for a multi-unit plant can either be lower or higher, depending on the strategies that the multi-plant organization chooses in reducing its capacity. It might also be possible that the multi-plant firm reduces capacity across all plants, through mutual coordination, which in this case increases the chances of survival for all its plants. Chen also found empirical support for his proposition, when studying the life duration of plants belonging to the US petroleum refining industry, over the 1981-86 period.

2.3.3 Industry specific factors

Entry (the displacement effect): The causal relationship running from entry to exit can be due to two effects: a *displacement effect* and the *effect of age and size on plant survival.* Gabzewicz and Thisse (1980) brought theoretical justification for the *displacement effect.* They showed there is an upper boundary on the number of firms, which can compete in any market. When this upper boundary is reached, any further entry results in the exit of already existing firms. Shapiro and Khemani (1987) suggested two reasons for the possible displacement of incumbents by new entrants: 1) to the extent that cost heterogeneity exists within an industry, lower cost entrants can displace higher cost incumbents; and 2) even if cost heterogeneity does not exist, investment in durable and specific assets creates a first mover advantage and a barrier to entry, which also reduces the possibilities for future displacement.

Audretsch (1995) stated that new entrants are always contributing to the exit of those in the next period. He introduced the notion of a 'revolving door', and explained that there is a close match between the identity of the exitors and the entrants of the previous period. There are two reasons for this effect: *age* and *size*, as newer plants are both younger and more likely to be smaller than incumbents (Dunne *et al.* 1988; Audretsch, 1994). Dunne *et al.* (1988), Mata and Portugal (1994), Baldwin (1995), Boeri and Bellman (1995) and Ilmakunnas and Topi (1999) all found a positive impact of (lagged) entry on exit.

Growth in demand: Due to the profitable opportunities that demand growth creates in markets, it can have a negative impact on exit. In fast growing industries, because of the room created in the market, there are more opportunities for firms to raise their market share, without posing any loss on other incumbents and provoking retaliatory reaction from them.

Theories that study the effect of demand fluctuations on profitability are controversial. On the one hand, some show that profits increase during times of economic boom, while the others show that during recession industry profits increase. Within a game theoretic framework, Green and Porter (1984) showed that industries' profit margins have a pro-cyclical behaviour, while Rotemberg and Saloner (1986) showed the opposite. Machin and Van Reenen (1993) studied the effect of aggregate business fluctuations on profitability for large UK companies, during the 1970s and 1980s. They found that firm-level profitability dropped sharply, during the 1980-81 recession, therefore showing a strong pro-cyclical behaviour.

However, McDonald (1999) found that for Australian manufacturing firms during the 1984-93 period, the effect of business cycles on profitability was dependent on the structural characteristics of industries. In more concentrated industries, profitability showed a pro-cyclical behaviour, while in less concentrated industries it showed a counter-cyclical behaviour. This reveals that the manner in which growth affects the profitability of firms and, consequently, their exit might depend on the structural characteristics of the markets, which evolves through various stages of the industries' life cycle.

Based on the evolutionary theory of the life cycle proposed by Gort and Klepper (1982), infant industries have a higher turnover of firms. This is due to a high level of uncertainty and imperfection of information, regarding the characteristics of the product, market demand and various other parameters. As industries mature, the market stabilises, information becomes more available, firm turnover decreases and, consequently, concentration increases. This can have different implications for the effect of growth on the profitability of firms populating these industries.

The empirical evidence regarding the direct effect of growth on exit is varied. Boeri and Bellman (1995) found that growth had an insignificant impact on exit. Audretsch (1994) found that, in the short run, growth had a negative impact on exit but in the long run it had no significant impact. Mata *et al.* (1995) found that in industries with high growth firms tended to last longer. However, when they also took account of entry, they found that plants operating in industries characterised with high growth and high entry faced a higher hazard rate. Mata and Portugal (1994) found that in faster growing industries firms survived longer. Finally, Disney *et al.* (1999) found that the age of plants had to be taken into account, if one wishes to study the effect of industry growth on exit. Before taking account of age, growth had no impact on exit, but once it was entered into the model as a joint age-demand variable, the effect became significant. They found that industry growth has a positive impact on exit, which reduced with the age of plants.

2.4 Conclusion

In this chapter the theoretical and empirical literature, in relation to the factors that determine entry and exit of plants, was reviewed. The conclusion that can be drawn is that, in the majority of cases, the theoretical literature does not provide us with "stylised facts" in relation to the impact of a given factor on entry/exit. Some factors can have a contradictory impact on entry/exit, which have been supported by a convincing line of arguments. Similarly, empirical findings in relation to the impact of given factors on entry/exit varied from one study to the other. This can also result from differences in the data that is used, the time period under study, different structural characteristics of the sampled industries or a wide range of other factors.

Chapter 3: Entry, Exit, Survival and Growth of Plants in UK Manufacturing Industries, 1974-97

3.1 Introduction

The process of entry and exit of firms has long been the focus of attention by economists. In line with the contestability theory, Baumol *et al.* (1982) describes entry as a disciplinary force in which only the mere threat of it can limit monopoly profits. On the other hand, some believe that entrants only operate on the fringe of industry and that they will exit shortly after entry, without having much impact on total manufacturing output. In this regard, entry is known as a 'hit and run process' and entrants are considered to be unimportant, and not making much contribution to industry's productivity. One such view is held by Shepherd (1984), who criticises the contestability theory and suggests that entry is a secondary force to internal conditions in determining the extent of competition. Which theory best describes the process of entry and exit in the UK manufacturing industries, depends on what can be discovered by empirical work.

Due to the lack of a comprehensive dataset, it had not been possible, previously, to capture the full magnitude and impact of these two market phenomena at the total manufacturing level. However, for the first time in the UK, the Office for National Statistics (ONS) has provided the researchers with a comprehensive plant level dataset, which contains a wide range of information on plants in the UK manufacturing industries from 1974 onwards. Using this dataset, it is possible to get a more comprehensive picture of the dynamics of entry and exit in the UK manufacturing industries.

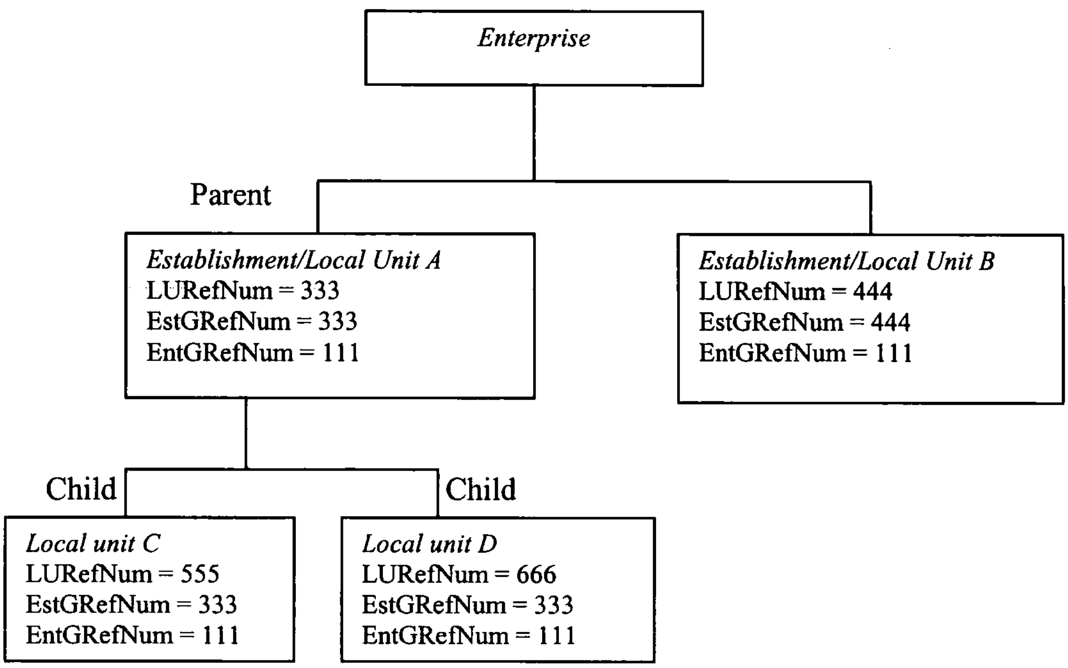
Therefore, the remainder of this chapter can be divided into the following sections. Section 3.2 provides an overview of the dataset and its associated strengths and weaknesses. Section 3.3.1 explains the way entry and exit are defined in our study. The industry aggregation level, at which entry and exit are calculated, is explained in Section 3.3.2. In order to capture the immediate magnitude of the entrants and the exitors, Section 3.3.3 provides annual (short-run) entry, exit and net entry rates for the manufacturing sector as a whole, over the 1974-97 period. In Section 3.3.4, entry and exit rate variations, across the four-digit manufacturing industries, over the 1974-97 period are examined. Section 3.3.5 tests for the existence of a consistent ranking of the four-digit manufacturing industries or years, over the 1974-97 period, in terms of the magnitude of their annual entry/exit rates. The post entry experience of the cohorts of entrants, that entered the manufacturing sector between 1974-97, is studied in Section 3.3.6. This is done by measuring their associated exit rate and hazard rate in each year following entry. In Section 3.3.7, the contribution of plants of different ages to total closures in each year are examined. Section 3.3.8 compares the post-entry experience of new plants and incumbents.

In Section 3.3.9, the post-entry growth of entrants is assessed, by looking at the average size of the surviving plants (measured in real gross value added), the overall size of the cohort of entrants, and average share of the cohort of entrants (from total manufacturing plants and real gross value added) in each year following entry. In addition, the accumulated share of entrants from the total manufacturing real gross value added, during the 1974-97 period, is noted. In Section 3.3.10 accumulated/long-run entry and exit rates are compared with the average annual/short-run rates in order to capture the long-run impact of entry and exit. Finally, Section 3.4 supplies the conclusion drawn from the findings in this chapter.

3.2 Data

The major source of data in this thesis comes from the individual records of the Annual Census of Production (ACOP), which is contained in the Annual Business Inquiry Respondent Database (ARD)[1]. A full description of the ARD is given in Oulton (1997), of which the important features are highlighted here. The structure of the ARD is mapped out in Figure 3.1. In the ARD an enterprise is defined as an ultimate entity that owns one or more local units[2]. The way to identify it is through the enterprise group reference number (EntGRefNum), which is assigned to all the local units under a common ownership. As is shown in Figure 3.1, local units A, B, C and D are owned by the same enterprise and, therefore, have the same EntGRefNum, which is equal to 111. This identifier also makes it possible to locate any change of ownership (as that results in a change in this reference number[3]).

Figure 3.1 Structure of the ACOP Respondent Database (the ARD)



[1] Except in Chapter 4, where some geographical specific variables have been collected from Regional Trends (see Regional Trends, various issues).
[2] A local unit in the ARD refers to a plant at a single location.
[3] In case of a single-plant unit, there are no other plants belonging to the owner enterprise, while for a multi-plant unit there is at least one other plant that is owned by the same enterprise.

An establishment is a local unit that supplies the answers to the questions on the census form (for the ACOP inquiry) for itself as well as for all the other local units for which it is responsible. A unique identifier, termed the establishment group reference number (EstGRefNum), is assigned to all the local units that are under its control. The ARD contains data on all the establishments that are potentially within the scope of ACOP enquiry. However, establishments can be further divided into two broad categories, those that have actually been selected for the ACOP inquiry (contained in the 'selected file') and those that have not been selected (contained in the 'non-selected file). The (stratified) selection criteria is based upon the employment of establishments and is mainly biased towards large establishments[4].

Both the selected and non-selected files hold various information such as: the Standard Industrial Classification (SIC80, SIC68 and SIC92), country of ownership, postcode, geographical region, and employment. However, the selected file holds some additional financial information, mainly regarding output and cost. The number of selected establishments varies between 14-19,000 per year and the non-selected are over 100,000. As the unit of analysis here is the local unit rather than the establishment, the information provided by the establishments has to be spread across all the local units, on whose behalf they are reporting. The way to do this is by multiplying a weight (called unit weight, which varies between 0 and 1) by the provided figures[5].

[4] Establishments with more than 500 employees are all included in the selected file, while sampling has been applied to smaller establishments. This way selection frame becomes mainly biased towards choosing large establishments. Therefore, in any analysis based on the selected file, weights will be used in order to make these establishments representative of the entire population of the establishments in the manufacturing industries. The reason for using weights and also the details of how weights are calculated are provided in the Appendix to this chapter.

[5] The higher the share of a local unit from the provided figures, the larger is its corresponding unit weight. Therefore, in case of a local unit that answers a census form only for itself, the associated unit weight is equal to 1. Hence, the unit weight simply is the employment share of a local unit from the total employment of the establishment.

Finally, a local unit (LU) in the ARD relates to a plant at a single location. Having a local unit reference number (LURefNum) makes it possible to trace a plant over time and find out the exact year that it opened and ultimately closed. This identifier remains the same if that particular plant changes ownership, or location, or if it stops and then restarts production after a few years.

Based on the definition of the local units and establishments, a local unit can then be divided into three distinct categories. First, local units that return a census form only for themselves and, therefore, are a local unit as well as an establishment; second, those local units that report information, not only for themselves but also on behalf of some other local units under their control which, therefore, makes the local unit also "parents"; and third, local units that are under the control of an establishment and, therefore, are a local unit and a "child". The simplest case is a local unit that returns a census form only for itself (therefore is also an establishment) and is owned by an enterprise, which does not own any other plants. In Figure 3.1, local unit A is an establishment and a "parent" because it answers the census form not only for itself but also on behalf of the local units C and D. In this case local units C and D have the same EstGRefNum (333) as local unit A (the EstGRefNum is equal to the LURefNum of the local unit A) and are a "child" to it. On the other hand, local unit B provides information for the ACOP inquiry only for itself and, therefore, is a local unit as well as an establishment.

There is an important issue regarding the nature of the ARD and that relates to the sampling frame, which did not remain the same during the 1974-97 period. Prior to 1984 the sampling frame, based on the establishment employment, was as follow:

1-19 (not sampled)

20-49 (1 in 4)

50-99 (1 in 2)

100+ (1 in 1)

In 1984 there was a change in business registration, based on the VAT register, to take a fuller account of smaller size plants. As a result, the sampling frame changed to

1-19	(not sampled)
20+ (in England)	(1 in 2)
20+ (excluding England)	(1 in 1)

In 1985, sampling again altered to the pre-1984 frame and, therefore, the total number of sampled establishments decreased.

In 1989 sampling increased to

1-19	(not sampled)
20+ (in England)	(1 in 2)
20+ (excluding England)	(1 in 1)

In 1990 sampling decreased to

1-19 (not sampled)

20-49 (1 in 4)

50-99 (1 in 2)

100+ (1 in 1)

In 1993 sampling changed to

20-49 (1 in 5)

50-99 (1 in 2)

100+ (1 in 1)

In 1994 there was a change to IDBR registration (Inter Departmental Business Register), which increased the overall number of contributors in the ACOP universe. During this process of change, especially in 1984 and 1994, it was not possible to match the plant identifier before and after change for many small plants. Therefore, a number of plant openings and closures seem to be taking place, which was due to ONS losing track of the already existing plants. These changes have to be taken into account, when carrying out the analysis in the next sections.

3.3 Empirical work

3.3.1 Defining entry and exit

Entry and exit in our study relates to the setting up of new plant (new capacity) and ceasing production at an ongoing plant (this can be done either by a new enterprise, called a "Greenfield" entrant, or by an existing enterprise[6]).

It might be argued that this is not the best way to measure entry and exit; rather they should be measured at firm (enterprise) level, as it is the firm rather than the plant that makes these decisions. Baldwin (1995) proposed two reasons for why one should look at the entry and the exit of plants rather than firms. These reasons were as follows: 1) as firms might operate more than one plant it is better to consider entry and exit at plant level and 2) it is the fate of plants that determines fate of a firm and also it is the introduction of new plant (new capacity) rather than a new firm that drives super normal profits down[7].

[6] The way to identify an enterprise in the ARD is through the enterprise group reference number, which was explained in Section 3.2.
[7] One could look at firm entry and exit, but it would be a different exercise.

3.3.2 Industry aggregation level

As discussed in Section 3.3.1, plants are the units of analysis in this study. Entry and exit can be measured either at the level of the manufacturing sector as a whole, or for individual industries. In the first case 'entry' is defined as the opening of a plant in the manufacturing sector and 'exit' as closure; and in the second case 'entry' is defined as the opening of a plant in a particular manufacturing industry and 'exit' as closure[8]. In this chapter in order to provide a broader overview, entry and exit mainly at the total manufacturing level will be examined.

3.3.3 Annual (short-run) entry and exit rates for total manufacturing

Before the analysis of the figures can take place, it needs to be decided whether to use either the selected and non-selected file (the entire population of plants in manufacturing), or only the selected file. As was explained in Section 3.2, two major changes to the registration of plants occurred: one in 1984 (change to VAT registration) and one in 1994 (change to IDBR registration), which resulted in many small plants being identified. However, in this process plants were assigned new identifiers and in some cases it was not possible to match the plant identities before and after the change. This is expected to affect the magnitude of the entry and exit measures. The reason is that the way in which entry and exit are identified in this study is through the plant identifier (LURefNum[9]). Entry occurs if a new LURefNum appears in a given year and exit takes place if an existing LURefNum no longer exists. Given these changes, one might observe additional entry and exit, which is not truly due to opening and closure of

[8] If firms are the units of analysis, then different levels of industry aggregation captures different aspects of entry and exit. When entry is measured at the total manufacturing level it only captures entry by outsiders, while entry into a particular industry may come from firms already existing in manufacturing. Similarly, exit from the manufacturing industries means total closure of firms, while exit from a particular industry can be by a firm that is still operating in other industries. Therefore, when entry and exit are added up across the individual industries, it is unlikely to be the same as when entry and exit are measured for the manufacturing industries as a whole. The lower the industry aggregation level, the higher is the frequency of entry and exit.

[9] Explained in Section 3.2.

plants. Therefore, it is necessary to find out the extent to which these changes affect entry and exit measures, using the entire population and the selected file.

First, using both the selected and non-selected file (the entire population), annual (short-run) entry, exit and net entry rates are calculated, at the total manufacturing level, for the 1974-97 period (see Table 3.1); these rates are measured both in terms of the actual number of plants and their employment. Annual entry rates, shown in column (1),

Table 3.1 Annual entry, exit and net entry rates, measured in terms of number of plants and employment, using both the selected and non-selected file, over the 1974-97 period (figures are percentages)

Year	Entry rate		Exit rate		Net entry rate	
	Plants (1)	Employment (2)	Plants (3)	Employment (4)	Plants (5)	Employment (6)
1974	11.7	3.2	4.9	1.3	6.8	1.9
1975	7.5	2.0	5.6	2.2	1.9	-0.2
1976	6.7	1.8	4.3	2.0	2.4	-0.2
1977	4.1	1.1	3.4	2.1	0.7	-1.0
1978	3.6	1.1	3.5	2.1	0.1	-1.0
1979	1.9	0.7	2.5	1.5	-0.6	-0.8
1980	3.5	1.8	4.0	2.4	-0.5	-0.6
1981	3.1	1.4	4.1	4.3	-1.0	-2.9
1982	3.9	1.6	9.1	4.0	-5.2	-2.4
1983	3.0	1.3	3.9	3.4	-0.9	-2.1
1984	62.9	10.2	52.5	10.3	10.4	-0.1
1985	61.6	8.9	59.7	10.0	1.9	-1.1
1986	15.9	4.1	12.5	4.4	3.4	-0.3
1987	16.4	4.7	14.0	5.1	2.4	-0.4
1988	17.7	4.4	14.8	5.2	2.9	-0.8
1989	24.2	4.9	22.4	5.7	1.8	-0.8
1990	13.7	3.8	16.6	5.6	-2.9	-1.8
1991	10.5	3.4	12.9	5.3	-2.4	-1.9
1992	36.1	6.8	31.2	7.3	4.9	-0.5
1993	32.7	5.4	38.5	9.6	-5.8	-4.2
1994	25.1	10.9	15.0	7.8	10.1	3.1
1995	33.7	18.2	20.9	9.6	12.8	8.6
1996	14.6	7.4	20.5	13.4	-5.9	-6.0
1997	16.6	12.7	17.8	21.4	-1.2	-8.7
Mean	18.0	5.1	16.4	6.1	1.6	-1.0

are calculated as the total number of plants that exist in the manufacturing sector in year t, but did not exist in year t-1, divided by the total number of plants in the manufacturing sector in year t. Annual exit rates, shown in column (3), are measured as the total number of plants that existed in the manufacturing sector in year t-1, but did not exist in year t, divided by the total number of plants in the manufacturing sector in year t-1. The rates in columns (2) and (4) are calculated using the same definitions as in column (1) and (3), respectively, but in terms of the employment of plants. Finally, the net entry rates are measured as the difference between the entry and the exit rates.

Initially, the comparisons of the columns reveals that entry and exit rates are greater when expressed in terms of the number of plants than in employment i.e. on average entry rates are 3.5 and exit rates are 2.7 times higher. Overtime, entry and exit rates are increasing, but the trend is not smooth. There is a sudden increase in both entry and exit rates, in 1984-85 and from 1992 onwards, which is much more pronounced when expressed in terms of the number of plants. The reason for this (as was explained in the first paragraph of this section) is partly related to the nature of the ARD rather than market dynamics[10]. However, this problem mostly only relates to small size plants, which is evident when the rates in terms of number of plants and employment are compared. Taking 1984 as an example: the entry rate from 1983 increased by 59.9% and the exit rate by 48.6%, when measured by the number of plants, while the entry rate only increased by 8.9% and the exit rate by 6.9%, when measured in terms of employment. The net entry rate in 1984 was 10.4%, in terms of number of plants, while –0.10% in terms of employment. This means that although there was a net increase in number of plants in 1984, total manufacturing employment due to net entry actually decreased.

There is not much consistency between the two measures in columns (5) and (6). While in some years the net entry rate is positive with regard to the number of plants, it is negative in terms of employment. On average, the entry and exit rates, between 1974-1997, are 18.0% and 16.4%, in terms of plants, and 5.1% and 6.1%, in terms of employment, respectively.

[10] Note that the associated changes in the registration of plants take affect gradually. Therefore, although the change into IDBR registration was finished by 1994, from 1992 it started affecting the registration of plants.

Next, entry and exit rates were calculated by using only the selected file. However, as was explained earlier, population weights have to be applied in order to make these plants representative of the entire manufacturing population. New entry, exit and net entry rates are presented in Table 3.2.

Table 3.2 Annual entry, exit and net entry rates, measured in terms of number of plants and employment, using the weighted selected file, over the 1974-97 period (figures are percentages)

	Entry rate		Exit rate		Net entry rate	
Year	**Plants (1)**	**Employment (2)**	**Plants (3)**	**Employment (4)**	**Plants (5)**	**Employment (6)**
1974	11.4	3.0	9.1	1.0	2.3	2.0
1975	6.7	1.8	7.5	2.1	-0.8	-0.3
1976	5.8	1.6	5.8	1.6	0.0	0.0
1977	3.5	1.0	5.0	1.9	-1.5	-0.9
1978	5.2	1.0	5.5	1.8	-0.3	-0.8
1979	2.9	0.7	5.2	1.4	-2.3	-0.7
1980	4.0	1.5	7.1	2.5	-3.1	-1.0
1981	3.4	1.3	9.1	3.5	-5.7	-2.2
1982	3.9	1.3	9.2	2.9	-5.3	-1.6
1983	3.0	1.2	7.1	2.6	-4.1	-1.4
1984	36.2	6.9	7.0	2.8	29.2	4.1
1985	32.8	6.0	6.7	3.0	26.1	3.0
1986	11.9	3.5	7.8	2.5	4.1	1.0
1987	13.8	4.2	7.5	2.9	6.3	1.3
1988	14.6	3.8	7.3	3.1	7.3	0.7
1989	16.9	4.3	8.4	3.4	8.5	0.9
1990	11.5	3.3	8.2	3.6	3.3	-0.3
1991	9.0	3.1	8.9	3.5	0.1	-0.4
1992	22.7	5.4	8.3	3.5	14.4	1.9
1993	12.7	3.1	8.0	3.7	4.7	-0.6
1994	31.7	10.4	14.0	6.7	17.7	3.7
1995	33.6	17.4	16.2	7.6	17.4	9.8
1996	13.1	6.9	25.1	12.5	-12.0	-5.6
1997	14.6	11.9	31.3	24.1	-16.7	-12.2
Mean	13.5	4.4	9.8	4.3	3.7	0.1

It can be seen that by using the weighted selected file, the two major jumps in the rates are reduced, although they have not completely disappeared, especially for entry rates in terms of number of plants. Net entry rates in columns (5) and (6) are also more consistent in comparison with those in Table 3.2. From 1983 to 1984, the entry rate increased by 34.2%, when measured in number of plants, and by 6%, when measured in employment, while there is no major jump in exit rates. The net entry rate also increased, although the increase is more pronounced, when measured in numbers of plants, than in terms of employment. Note that the subsequent changes in 1984 and 1994 to the population of plants resulted in an increase in the entry and exit rates, since there was an artificial increase in the numerator due to an increase in the number of small size plants that entered and exited[11]. However, the denominators of the entry and exit rates (the entire population of the manufacturing plants) were not affected as much. Section 3.2 shows that sampling was carried out on the basis of establishment employment, which was mainly biased towards large establishments to the extent that the establishments with employment between 1 and 19 were exempted. This makes it clear that if the selected file is going to be used it has to be weighted in order to be a representative of the entire population of the manufacturing plants and, also, that the weighted selected file is less affected by the changes that happened in the registration of plants, as it only contains a sampled number of small plants. Therefore, from now on the weighted selected file is going to be used in all the analyses.

Annual entry and exit rates in Table 3.2 are plotted against time in Figures 3.2 and 3.3. One can see that while both rates are increasing over time, the trend is smoother for exit rates and more volatile for entry rates. While entry rate (measured in number of plants) reduces significantly after 1985 (from 32.8% to 11.9%) it stays relatively high in comparison to the pre-1984 period. Post-1989 there is no specific trend in entry rates (measured in number of plants) as they are increasing in some years and decreasing in others. The importance of entry is much less, when measured in terms of employment. However, the post-1993 entry rate increased to the extent that in 1997 entrants account for 11.9% of total manufacturing employment.

[11] Entry rate is measured as the total number of plants/the employment of plants, that exist in year t in the manufacturing sector, but did not exist in year t-1, divided by the total number of plants/employment in the manufacturing sector, in year t. Exit rate is measured as the total number of plants/the employment of plants, that existed in year t-1 in the manufacturing sector, but did not exist in year t, divided by the total number of plants/employment of the manufacturing sector, in year t-1.

Figure 3.2 The annual entry and exit rates, measured in terms of the number of plants, using the weighted selected file, over the 1974-97 period

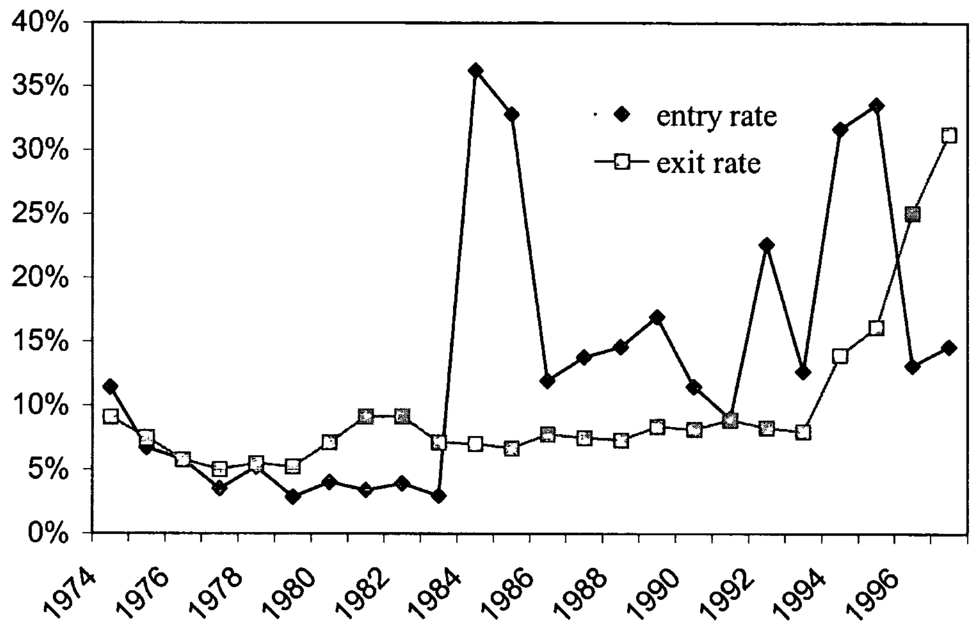
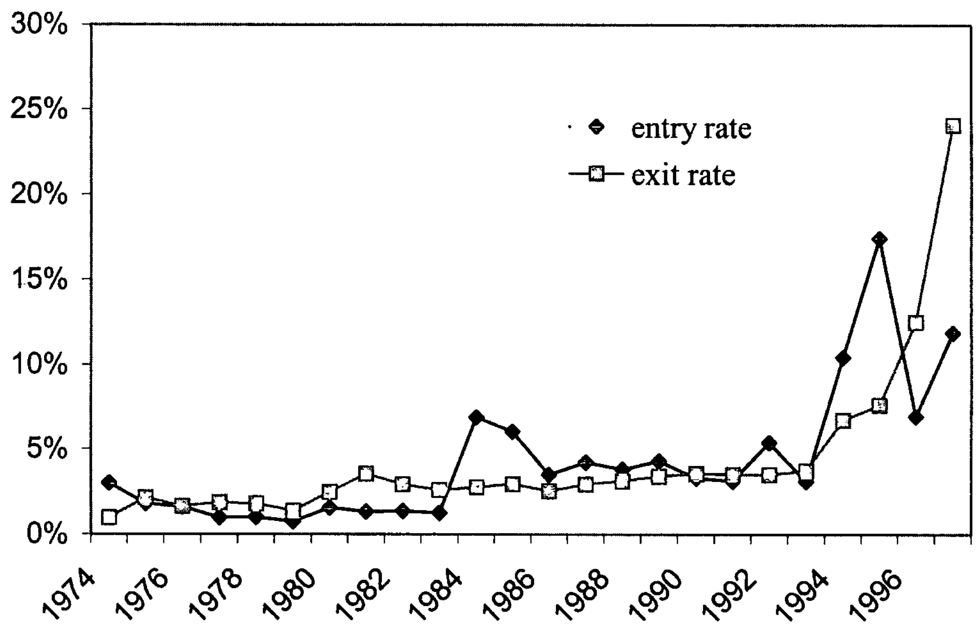


Figure 3.3 The annual entry and exit rates, measured in terms of employment, using the weighted selected file, over the 1974-97 period



The same scenario repeats itself for exit rates (both in terms of number of plants and employment). Post-1993 the exit rate increases, although not as much when measured in terms of employment. The last two years are characterised by a significantly high exit rate, reaching a maximum of 31.3% in 1997, when measured in terms of the number of plants, and 24.1%, when measured in terms of employment. Overall, exit rates are more stable throughout 1974-97, in comparison with entry rates. On average, during 1974-97, the entrants accounted for 13.5% of the number of plants in the manufacturing sector and 4.4% of employment and the exitors for 9.8% of the number of plants and 4.3% of employment.

This section demonstrates that: 1) both entry and exit rates in the UK manufacturing industries have been increasing, over the 1974-97 period. This shows that manufacturing was becoming more competitive over the period and more plants took their chance in various industries; 2) entry and exit rates are less important, when measured in terms of employment, rather than the stock of plants. This reveals that the high entry and exit rates were due, mainly, to the entry and exit of small plants. This result was also found by Dunne *et al.* (1988), when studying firm entry and exit in US manufacturing industries, over the 1963-82 period. They found that entry rates averaged between 41.4% and 51.8%, while their employment share ranged between 13.9% and 18.8%. In the same way, exit rates averaged between 41.7% and 50%, while their employment share was between 14.8% and 19.5%. Schwalbach (1991) also found that in German manufacturing industries between 1983-85, entry and exit rates, measured in terms of number of entrants, averaged between 11.5% and 13.8%, while their market share averaged between 8.1% and 9.2%, respectively; and 3) exit rates, on average, over time were lower than entry rates, when measured in terms of number of plants, although there were equally important, when measured in terms of employment. This implies that over the period in question, on average, a large number of small plants entered the manufacturing sector. On the other hand, the exiting plants were less in numbers and larger is terms of employment size. This is in line with the finding of Schwalbach (*op. cit*), who found that entrants and exitors are, on average, small, but exiting firms were larger than entrants.

3.3.4 Annual (short-run) entry and exit rates variations, across the four-digit manufacturing industries, over the 1974-97 period

In this section an attempt is made to discover which one of the industry specific, or time specific effects, has had the more significant impact on entry and exit rate variations, over the 1974-97 period. To do this, one needs to measure entry and exit rates at a lower level of aggregation. Therefore, though entry and exit rates are defined in the exactly the same way as in Section 3.3.3, in this section they are measured at the four-digit SIC manufacturing level. Correlations between *entry rate*$_t$ and *entry rate*$_{t-n}$ are provided in Tables 3.3 and 3.4 and *exit rate*$_t$ and *exit rate*$_{t-n}$ in Tables 3.5 and 3.6, in which 'n' refers to the number of lags in years[12]. Table 3.3 reports the correlation between *entry rate*$_t$ and *entry rate*$_{t-n}$, when the entry rates are measured in terms of the number of plants and Table 3.4 reports the same correlation, but when entry rates are measured in terms of employment. Similarly, Table 3.5 reports the correlations between *exit rate*$_t$ and *exit rate*$_{t-n}$, when the exit rates are measured in terms of the number of plants and Table 3.6 reports the same correlation, but when the exit rates are measured in terms of employment. A positive time series correlation in Tables 3.3 and 3.4 indicates that industries with higher/lower than average *entry rate* in one year, will tend to have higher/lower than average *entry rate* in a different year, while in Tables 3.5 and 3.6 indicates that industries with higher/lower than average *exit rate* in one year will

[12] Therefore, n equal to 1 shows the correlation between entry rates (at the four-digit manufacturing level) of any two adjacent years.

Table 3.3 Correlations between entry rate$_{t-n}$ and entry rate$_t$ (measured in terms of number of plants), at the four-digit manufacturing level, over the 1974-97 period

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974	1.000																							
1975	0.118	1.000																						
1976	0.125	0.012	1.000																					
1977	0.082	-0.001	0.180	1.000																				
1978	0.059	0.076	-0.021	0.033	1.000																			
1979	0.072	0.136	-0.037	0.124	0.147	1.000																		
1980	0.074	0.086	0.119	0.112	0.019	0.246	1.000																	
1981	0.205	0.009	0.024	0.190	0.064	-0.040	0.119	1.000																
1982	0.195	0.100	0.118	0.138	0.013	0.062	0.112	0.141	1.000															
1983	-0.055	-0.006	-0.002	0.028	0.244	0.040	-0.018	0.233	-0.003	1.000														
1984	0.203	0.099	0.149	-0.036	0.044	-0.026	-0.007	-0.038	0.242	-0.076	1.000													
1985	0.128	0.116	0.124	0.243	-0.041	0.040	0.185	0.095	0.203	-0.012	0.234	1.000												
1986	0.069	0.005	0.107	0.112	0.039	0.137	0.050	0.110	0.111	0.150	0.038	0.167	1.000											
1987	-0.056	0.036	0.004	0.162	-0.019	-0.109	0.036	0.003	0.126	-0.024	0.064	0.082	0.181	1.000										
1988	0.082	0.072	0.011	0.130	0.034	0.228	0.127	0.062	0.077	-0.041	0.005	0.001	0.141	0.089	1.000									
1989	0.138	0.125	0.024	0.130	-0.003	0.046	0.167	0.131	0.129	-0.062	0.177	0.079	-0.036	0.089	0.082	1.000								
1990	-0.023	0.066	0.122	0.051	0.251	0.344	0.170	-0.034	0.015	0.065	0.092	-0.040	0.122	0.098	0.201	0.018	1.000							
1991	-0.062	-0.066	0.149	0.124	0.004	-0.025	0.144	0.079	0.042	0.186	-0.086	0.032	-0.038	-0.060	0.056	0.065	0.052	1.000						
1992	0.168	0.007	0.088	0.163	0.050	0.127	0.144	-0.045	0.263	0.022	0.165	0.162	0.080	0.131	-0.021	0.097	0.076	0.010	1.000					
1993	0.169	0.015	-0.073	0.085	0.061	0.026	0.093	0.266	-0.028	0.253	-0.017	0.056	0.098	0.123	0.089	0.120	0.132	0.152	0.011	1.000				
1994	0.092	0.079	-0.021	0.100	-0.044	-0.044	-0.026	0.036	-0.087	0.015	0.085	0.144	0.011	0.042	-0.018	0.087	-0.074	-0.048	-0.080	-0.019	1.000			
1995	0.069	0.082	0.033	-0.003	0.133	-0.091	-0.082	0.100	0.055	-0.026	0.107	0.063	0.051	0.123	0.130	-0.055	-0.005	0.008	-0.002	0.034	0.097	1.000		
1996	0.059	0.054	0.089	0.050	0.023	-0.139	-0.056	0.129	-0.064	0.396	0.000	0.139	-0.030	0.019	-0.027	0.007	-0.071	0.130	0.067	0.135	0.186	0.309	1.000	
1997	0.014	-0.056	0.004	-0.013	0.090	-0.109	0.021	-0.028	-0.113	-0.126	-0.006	-0.010	-0.106	-0.076	0.035	-0.008	-0.110	0.036	0.093	0.045	0.172	0.195	0.134	1.000

Table 3.4 Correlations between entry rate$_{t-n}$ and entry rate$_t$ (measured in terms of employment), at the four-digit manufacturing level, over the 1974-97 period

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974	1.000																							
1975	0.248	1.000																						
1976	0.336	0.061	1.000																					
1977	0.291	0.042	0.235	1.000																				
1978	0.289	0.291	0.196	0.137	1.000																			
1979	0.343	0.231	0.177	0.292	0.149	1.000																		
1980	0.306	0.042	0.319	0.203	0.167	0.226	1.000																	
1981	0.249	-0.012	0.178	0.124	0.016	0.195	0.256	1.000																
1982	0.259	0.141	0.288	0.284	0.139	0.015	0.211	0.201	1.000															
1983	0.099	-0.015	0.076	0.191	0.321	0.034	0.043	0.167	0.152	1.000														
1984	0.238	0.403	0.376	0.031	0.154	0.063	0.077	0.038	0.222	-0.046	1.000													
1985	0.181	0.178	0.262	0.178	0.134	0.025	0.056	0.040	0.241	0.000	0.296	1.000												
1986	0.300	0.035	0.381	0.167	0.110	0.121	0.310	0.355	0.264	0.132	0.222	0.286	1.000											
1987	0.131	0.057	0.225	0.146	0.054	0.097	0.196	0.195	0.204	0.016	0.259	0.276	0.347	1.000										
1988	0.215	0.116	0.135	0.132	0.019	0.146	0.180	0.140	0.260	-0.031	0.141	0.178	0.185	0.290	1.000									
1989	0.248	0.152	0.335	0.168	0.155	0.087	0.373	0.249	0.322	-0.032	0.348	0.217	0.259	0.343	0.268	1.000								
1990	0.205	0.307	0.115	0.062	0.132	0.160	0.187	0.014	0.095	0.023	0.211	0.121	0.098	0.136	0.361	0.139	1.000							
1991	0.092	-0.068	0.108	0.069	0.047	-0.004	0.130	0.104	0.092	0.141	0.000	0.084	0.114	0.121	0.170	0.125	0.103	1.000						
1992	0.133	0.035	0.112	0.294	0.084	-0.017	0.126	0.123	0.268	0.121	0.096	0.082	0.047	0.146	0.077	0.247	0.051	0.043	1.000					
1993	0.157	-0.016	0.079	0.086	0.124	0.037	0.195	0.230	0.101	0.145	0.062	0.235	0.135	0.169	0.219	0.292	0.179	0.213	0.088	1.000				
1994	0.051	0.001	0.022	0.061	0.035	-0.041	0.121	0.000	0.035	0.014	0.127	0.100	0.083	0.141	0.041	0.135	0.049	0.058	0.010	0.171	1.000			
1995	0.103	0.014	0.136	0.146	-0.013	-0.052	0.158	0.230	0.085	0.098	0.122	0.192	0.213	0.211	0.106	0.167	0.008	0.023	0.079	0.259	0.124	1.000		
1996	0.154	-0.028	0.196	-0.003	0.008	-0.025	0.202	0.047	-0.036	0.054	0.001	0.187	0.183	0.113	0.095	0.111	0.094	0.262	0.071	0.162	0.061	0.384	1.000	
1997	-0.002	-0.036	-0.001	-0.002	-0.086	-0.059	0.123	0.058	-0.028	-0.011	0.017	0.100	-0.024	0.035	0.020	0.124	-0.056	0.013	0.303	0.148	0.092	0.231	0.167	1.000

Table 3.5 Correlations between exit rate$_{t-n}$ and exit rate$_{t}$ (measured in terms of number of plants), at the four-digit manufacturing level, over the 1974-97 period

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974	1.000																							
1975	0.344	1.000																						
1976	0.341	0.260	1.000																					
1977	0.348	0.392	0.208	1.000																				
1978	0.285	0.320	0.453	0.264	1.000																			
1979	0.336	0.232	0.382	0.246	0.425	1.000																		
1980	-0.128	-0.106	0.028	-0.097	-0.041	-0.067	1.000																	
1981	0.040	0.054	0.190	0.050	0.078	0.041	0.019	1.000																
1982	0.091	0.104	0.075	0.043	0.155	0.138	-0.005	0.149	1.000															
1983	0.167	0.063	0.037	-0.029	0.101	0.072	0.025	0.207	0.210	1.000														
1984	0.044	0.086	0.033	0.268	0.094	0.068	-0.016	0.023	-0.024	-0.103	1.000													
1985	0.033	-0.069	0.082	0.043	0.039	0.132	0.033	0.109	0.048	0.022	-0.069	1.000												
1986	0.124	0.126	0.192	0.071	0.046	0.123	0.201	-0.004	-0.007	-0.019	0.052	-0.049	1.000											
1987	0.201	0.035	-0.064	0.046	-0.052	0.053	0.055	0.024	-0.013	0.124	0.142	0.091	0.055	1.000										
1988	-0.059	0.002	0.015	0.026	0.123	-0.008	-0.005	0.047	-0.008	-0.112	0.144	-0.005	-0.027	0.213	1.000									
1989	0.062	-0.027	0.179	0.114	0.133	0.042	0.131	0.052	0.126	0.143	0.135	-0.043	0.003	-0.002	0.034	1.000								
1990	0.024	0.007	0.173	0.131	0.107	0.127	-0.068	-0.072	-0.112	-0.092	0.361	-0.017	0.066	0.050	0.066	0.218	1.000							
1991	-0.010	-0.033	-0.051	-0.007	-0.064	0.028	0.141	0.008	-0.043	0.054	-0.046	-0.051	0.063	0.077	-0.018	0.071	-0.135	1.000						
1992	0.075	-0.067	0.004	-0.006	-0.006	-0.008	0.047	-0.083	-0.115	0.018	0.019	0.022	-0.040	0.092	-0.075	0.013	0.113	0.053	1.000					
1993	0.035	-0.036	-0.089	-0.022	-0.003	-0.025	-0.052	-0.041	0.126	0.003	0.048	0.015	-0.028	0.192	0.219	-0.048	0.053	0.136	-0.024	1.000				
1994	0.013	0.057	0.013	0.047	-0.012	0.019	-0.017	0.052	0.069	-0.087	0.067	0.085	0.000	0.105	-0.008	-0.144	-0.013	-0.079	0.117	0.195	1.000			
1995	0.091	0.117	0.007	0.008	0.045	-0.141	0.075	0.037	0.031	0.031	0.079	-0.079	0.122	0.098	0.112	0.073	-0.075	0.065	0.065	0.065	-0.023	1.000		
1996	0.132	0.120	0.112	0.018	0.075	0.081	0.081	0.014	-0.027	-0.001	-0.045	0.001	-0.043	-0.007	0.017	0.046	-0.047	0.138	0.065	-0.030	-0.035	0.133	1.000	
1997	0.147	0.126	0.031	0.204	0.123	0.134	0.014	-0.086	0.001	-0.026	0.045	-0.057	-0.113	-0.031	0.149	0.019	-0.046	0.083	0.034	-0.006	0.008	0.044	0.291	1.000

Table 3.6 Correlations between exit rate$_{t-n}$ and exit rate$_t$ (measured in terms of employment), at the four-digit manufacturing level, over the 1974-97 period

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974	1.000																							
1975	0.221	1.000																						
1976	0.190	0.350	1.000																					
1977	0.265	0.286	0.413	1.000																				
1978	0.200	0.237	0.317	0.186	1.000																			
1979	0.207	0.170	0.264	0.151	0.497	1.000																		
1980	-0.059	-0.018	0.028	-0.069	0.098	0.013	1.000																	
1981	-0.071	0.144	0.094	0.062	0.136	0.062	-0.022	1.000																
1982	0.339	0.070	-0.004	0.031	0.122	0.107	0.005	0.158	1.000															
1983	0.030	0.160	0.168	0.037	0.186	0.084	-0.018	0.286	0.060	1.000														
1984	0.091	0.040	0.020	0.079	0.041	-0.044	0.029	0.044	0.303	0.025	1.000													
1985	0.006	-0.065	0.054	-0.067	0.011	-0.018	0.078	0.072	-0.036	0.109	-0.016	1.000												
1986	0.043	0.113	0.165	0.061	0.056	0.020	0.145	0.051	0.097	0.095	-0.001	0.187	1.000											
1987	-0.014	0.015	0.002	0.059	0.142	0.107	0.074	-0.077	-0.112	0.083	-0.028	0.027	0.081	1.000										
1988	-0.047	0.061	-0.027	0.005	0.036	0.047	0.018	-0.002	-0.034	-0.062	0.126	-0.052	0.038	0.153	1.000									
1989	0.014	0.002	0.082	0.135	0.122	-0.026	0.248	0.070	0.040	0.144	0.064	0.089	0.096	0.099	0.151	1.000								
1990	-0.050	0.043	0.173	0.079	0.189	0.304	0.055	0.014	0.080	0.034	0.135	0.021	0.095	0.146	0.170	0.082	1.000							
1991	-0.025	0.114	0.052	0.018	-0.029	-0.037	0.057	0.093	-0.042	0.109	0.143	-0.004	0.226	0.036	0.166	0.016	0.004	1.000						
1992	-0.027	-0.022	0.095	0.218	0.013	-0.007	0.070	0.061	0.003	0.009	0.006	0.035	0.153	0.046	-0.140	0.040	0.141	0.054	1.000					
1993	-0.050	-0.016	-0.023	-0.052	-0.024	-0.036	0.051	-0.056	-0.059	0.097	-0.051	-0.026	0.000	0.037	0.022	0.101	0.090	0.019	-0.008	1.000				
1994	-0.004	0.058	0.192	-0.011	0.112	0.087	0.115	-0.011	-0.084	0.022	-0.020	0.009	0.182	-0.002	-0.036	0.046	0.177	0.058	0.248	0.287	1.000			
1995	-0.050	0.031	0.059	0.028	0.120	-0.105	0.150	0.049	0.025	0.066	0.009	-0.014	0.073	0.007	0.094	0.232	0.148	0.124	0.065	0.116	0.173	1.000		
1996	0.021	0.144	0.107	0.053	0.236	0.246	0.053	0.032	0.084	0.028	-0.007	-0.032	0.015	0.125	0.007	0.026	0.135	0.019	0.067	-0.008	0.170	0.250	1.000	
1997	0.055	0.135	0.127	-0.022	0.084	-0.012	-0.003	0.029	-0.032	0.010	-0.037	-0.045	-0.048	-0.023	0.176	-0.014	0.122	0.097	-0.004	-0.025	0.118	0.306	0.354	1.000

tend to have higher/lower than average *exit rate* in a different year. Comparisons between the tables reveals that entry rates, when measured in terms of employment, have the highest correlation between any two years. However, in general the correlations are not very high and, therefore, these results indicate that entry/exit rate variations across the four-digit manufacturing industries, over the 1974-97 period, are due more to transitory rather than industry specific effects. On the contrary, Dunne *et al.* (1988) and Cable and Schwalbach (1991) found that entry and exit measures for industries, in their sample, tended to be stable over time (the most stable measure was the market share of entering and exiting firms). This led them to conclude that entry and exit differences, across industries and over time, were due mostly to the industry specific rather than time specific effects.

3.3.5 The Kruskal-Wallis test for the existence of a consistent ranking of (i) four-digit manufacturing industries or (ii) years, over the 1974-97 period, in terms of the magnitude of their annual entry/exit rates.

Given that time specific factors have had a more significant impact on entry and exit variations, it is beneficial to statistically test, over the 1974-97 period: 1) whether there were certain four-digit manufacturing industries with *entry rates* consistently higher/lower than the average, or, with *exit rates* consistently higher/lower than the average and 2) whether, in certain years, *entry rates* across four-digit manufacturing industries are consistently higher/lower than the average, or, *exit rates* across four-digit manufacturing industries, are consistently higher/lower than the average.

The null in the first hypothesis is that if four-digit manufacturing industries, over the 1974-97 period, are ranked, based on the magnitude of their annual entry/exit rates, there will be no specific order in the ranking. In other words, all industries could appear in any positions in the ranking list. Therefore, the alternative hypothesis is that certain industries always appear at the top of the ranking list and some others at the bottom. In the sample, there are 208 different four-digit manufacturing industries, followed over 24 years. However, not all industries appear in all years, which leave one with 4963 annual entry/exit rates to rank. Ranking the annual entry/exit rates from the highest to the lowest (with the highest value having the rank 1 and the lowest value having the rank 4963), the observed mean rank, by four-digit manufacturing industry, is then calculated.

Next, based on the magnitude of their observed mean ranks, the four-digit manufacturing industries are ranked, but this time from the lowest to the highest (with the lowest observed mean rank having the rank 1 and the highest observed mean rank having the rank 208; this is shown for entry rates in Table 3.7 and for exit rates in Table 3.8[13]). The optimum mean ranks in Tables 3.7 and 3.8 are calculated based on the assumption that a perfectly consistent ranking exists across all the four-digit manufacturing industries. A perfectly consistent ranking could exist, if a given industry, having an observed mean rank 'R', was occupying the R^{th} 24 positions in the first ranking list.

For example, the process engineering contractors industry, in Table 3.7, has the lowest observed mean rank. This means, on average, that it has the highest entry rates over the 1974-97 period. Assuming a perfectly consistent ranking, one would expect this industry to occupy the first 21 positions in the initial ranking list, which would result in an optimum mean rank of 11[14]. On the other hand, the electronic data processing equipment industry has the highest observed mean rank in Table 3.7. This means that it has the lowest observed entry rates, over the 1974-1997 period. If a perfectly consistent ranking existed, this industry would have an optimum mean rank of 4951.5, as it would

[13] Due to the large number of industries, only the top ten industries with the highest and the ten with the lowest observed mean ranks are reported

[14] Having only 21 observations for the process engineering contractors industry, the average of 1,2,.., 21 would be equal to 11. This means that the expected mean rank would be equal to 11, if this industry always had the highest entry rates over the 1974-97 period and therefore, would occupy the first 21 positions in the first ranking list.

Table 3.7 Mean ranks of entry rates, by four-digit manufacturing industry

Four digit manufacturing sector	Number of observations	Rank	Mean rank Optimum	Mean rank Observed
Industries with the ten highest entry rates				
Process engineering contractors	21	1	11.0	453.0
Slaughterhouses	22	2	32.5	453.0
Animal by-product processing	22	3	54.5	453.0
Fur goods	16	4	73.5	453.0
Photographic and cinematographic processing laboratories	9	5	86.0	453.0
Chemical treatment of oils and fats	23	6	102.0	792.3
Salt extraction and refining	23	7	125.0	844.1
Spinning and weaving of flax, hemp & ramie	24	8	148.5	877.8
Sugar and sugar by products	24	9	172.5	901.2
Margarine and compound cooking fats	24	10	196.5	908.2
Industries with the ten lowest entry rates				
Spectacles and unmounted lenses	24	199	4735.5	3521.0
Alarms and signalling equipment	24	200	4759.5	3542.3
Soft furnishings	24	201	4783.5	3547.9
Heat and surface treatments of metals, inclusive sintering	24	202	4807.5	3564.5
Sawmilling, planning, etc. of wood	24	203	4831.5	3567.8
Other building products of concrete, cement, plaster	24	204	4855.5	3599.7
Ready mixed concrete	24	205	4879.5	3633.8
Plastics building products	24	206	4903.5	3671.1
Metal doors, windows, etc.	24	207	4927.5	3676.4
Electronic data processing equipment	24	208	4951.5	3833.9

Note: due to the large number of industries mean ranks are reported only for the ten industries with the highest and lowest entry rate.

Table 3.8 Mean ranks of exit rates, by four-digit manufacturing industry

Four digit manufacturing sector	Number of observations	Rank	Mean rank Optimum	Mean rank Observed
Industries with the ten highest exit rates				
Photographic and cinematographic processing laboratories	9	1	5.0	451.5
Fur goods	16	2	18.0	451.5
Process engineering contractors	21	3	37.5	451.5
Slaughterhouses	22	4	59.5	451.5
Animal by-product processing	22	5	81.5	451.5
Chemical treatment of oils and fats	23	6	104.5	639.5
Salt extraction and refining	23	7	128.0	1189.5
Starch	24	8	151.5	1189.5
Margarine and compound cooking fats	24	9	175.5	1233.8
Motor cycles and parts	24	10	199.5	1273.0
Industries with the ten lowest exit rates				
Electronic data processing equipment	24	199	4735.5	3359.6
Women's and girl's light outwear, lingerie and infants' wear	24	200	4759.5	3422.8
Machinery for working wood, rubber, plastics, leather, making paper, glass, bricks and similar materials; laundry and dry cleaning machinery	24	201	4783.5	3423.4
Other building products of concrete, cement, plaster	24	202	4807.5	3440.1
Extraction of stone, clay, sand & gravel	24	203	4831.5	3440.9
Printing ink	24	204	4855.5	3467.6
Compound animal feeds	24	205	4879.5	3469.0
Spinning and doubling on the cotton system	24	206	4903.5	3548.4
Soft drinks	24	207	4927.5	3642.8
Sawmilling, planning, etc. of wood	24	208	4951.5	3938.7

Note: Due to the large number of industries mean ranks are reported only for the ten industries with the highest and lowest exit rate.

occupy the last (208th) 24 positions in the initial ranking list[15]. The observed and optimum mean ranks for the exit rates (shown in Table 3.8) are calculated in the same way as for the entry rates.

The Kruskal-Wallis test is implemented by comparing the observed mean ranks with an expected mean rank that would result if a perfectly random ranking existed across all the four-digit manufacturing industries[16]. The chi-square test of the null hypothesis that there is no significant difference between the observed and the expected mean ranks is highly significant[17]. Therefore, one can reject the null hypothesis that there is no consistent ranking of the four-digit manufacturing industries in terms of their entry/exit rates, over the 1974-1997 period. In other words, over the 1974-97 period, there were certain four-digit manufacturing industries with consistently higher/lower than average *entry rates*. Similarly, certain four-digit manufacturing industries have, consistently, higher/lower than average *exit rates*.

In order to test the second hypothesis, the entry/exit rates for the four-digit manufacturing industries, over the 1974-1997 period (4963 observations), are ranked from the highest to the lowest (with the highest entry/exit rate having the rank 1 and the lowest having the rank 4963). However, on this occasion, the observed mean rank is calculated by year. Next, years are ranked, based on the value of their observed mean ranks (with the lowest observed mean rank having the rank 1 and the highest observed mean rank having the rank 24). The optimum mean rank is also calculated based on the assumption that a perfectly consistent ranking of the years exists across all the four-digit

[15] Having 24 observations for this industry, if it was to occupy the last 24 positions in the first ranking list, it would have an expected mean rank of 4951.5, which is equal to the average value of 4940, 4941,..., 4963.

[16] Note that the expected mean ranks are calculated based on the assumption that the null hypothesis is true (these values are not reported in Tables 3.7 and 3.8). This means that if the four-digit manufacturing industries were ranked based on the value of their entry/exit rates, over the 1974-97 period, there would be no specific order in the ranking and all industries would appear in all positions in the ranking list.

[17] The value of the χ^2 test of the null hypothesis of no consistency of the four-digit manufacturing industry's *entry rates*, over the 1974-97 period, is equal to 1198.507 and the associated p-value is equal to 0.000 (the degree of freedom is equal to 207). Similarly, the value of the χ^2 test of the null hypothesis of no consistency of the four-digit manufacturing industry's *exit rates*, over the 1974-97 period, is equal to 868.175 and the associated p-value is equal to 0.000 (the degree of freedom is equal to 207).

manufacturing industries. A perfectly consistent ranking could exist if a given year, having an observed mean rank 'R', was occupying the Rth 208 positions in the first ranking list.

Therefore, having a perfectly consistent ranking, one would expect the year with the highest entry/exit rate to occupy the 1st 208 places in the initial ranking list and, therefore, have an expected mean rank equal to 104.5[18] (The observed and the optimum mean ranks by year are reported in Tables 3.9 for the *entry rates*, and in Table 3.10 for the *exit rates*). The Kruskal-Wallis test is then implemented by comparing the observed mean ranks with an expected mean rank that would result if a perfectly random ranking of years existed across all the four-digit manufacturing industries[19]. The p-value associated with the test of the null hypothesis, that there is no consistent ranking of the years, in terms of the entry/exit rates, is significant at better than the 1% level of significance. Therefore, one can reject the null hypothesis that there is no significant difference between the observed and the expected mean ranks[20]. This means that certain years, in the sample (from 1974-97), were characterised with significantly higher/lower than average *entry rates*. Similarly, certain years were characterised with significantly higher/lower than average *exit rates*.

In Table 3.9, it is evident that the highest entry rates are observed in the late 1970s (1977, 1978 and 1979) and the lowest entry rates in the late 1990s (1994, 1996, 1997, 1995). Similarly, in Table 3.10 the highest exit rates are observed in the second half of the 1970s and the lowest exit rates in the late 1990s. This shows that entry and exit rates were higher in years of boom (during the late 1970s). However, the downturn in the

[18] The actual number of four-digit manufacturing industries in 1979 (the year with the highest observed mean rank) is equal to 207. Therefore the expected mean rank for that year is equal to 104, which is the average of 1, 2,..., 207.
[19] The expected mean ranks are not reported in Tables 3.9 and 3.10
[20] The value of the χ^2 test for the consistency of the entry rates, across the 1974-1997 period, is equal to 1224.119 and the associated p-value is equal to 0.000 (the degree of freedom is equal to 23). Similarly, the value of the χ^2 test for the consistency of the exit rates, across 1974-97 period, is equal to 1447.129 and the associated p-value is equal to 0.000 (the degree of freedom is equal to 23).

Table 3.9 Mean ranks of entry rates, by year

Year	Number of observations	Rank	Mean rank	
			Optimum	Observed
1979	207	1	104.0	1364.6
1978	207	2	311.0	1503.4
1977	207	3	518.0	1517.5
1983	205	4	724.0	1623.6
1981	207	5	930.0	1706.0
1982	205	6	1136.0	1746.5
1980	207	7	1342.0	1850.5
1976	207	8	1549.0	2017.0
1975	207	9	1756.0	2057.1
1991	207	10	1963.0	2377.3
1993	206	11	2169.5	2426.5
1990	207	12	2376.0	2545.3
1986	208	13	2583.5	2549.5
1974	207	14	2791.0	2561.8
1987	208	15	2998.5	2709.8
1988	208	16	3206.5	2782.5
1989	208	17	3414.5	2833.5
1992	207	18	3622.0	2913.6
1985	208	19	3829.5	2971.1
1984	208	20	4037.5	3219.5
1996	204	21	4243.5	3229.3
1994	206	22	4448.5	3286.2
1997	198	23	4650.5	3725.8
1995	205	24	4852.0	3999.6

Table 3.10 Mean ranks of exit rates, by year

Year	Number of observations	Rank	Mean rank	
			Optimum	Observed
1974	207	1	104.0	1288.8
1979	207	2	311.0	1551.0
1978	207	3	518.0	1672.1
1976	207	4	725.0	1674.7
1977	207	5	932.0	1709.1
1975	207	6	1139.0	1811.2
1980	207	7	1346.0	2050.8
1986	208	8	1553.5	2131.5
1983	205	9	1760.0	2192.2
1985	208	10	1966.5	2301.7
1987	208	11	2174.5	2384.1
1988	208	12	2382.5	2484.1
1989	208	13	2590.5	2486.7
1993	206	14	2798.0	2500.1
1984	208	15	3004.0	2502.5
1990	207	16	3210.5	2629.3
1991	207	17	3418.0	2650.3
1982	205	18	3625.0	2664.1
1992	207	19	3832.0	2664.7
1981	207	20	4039.0	2683.5
1994	206	21	4245.5	3351.0
1995	205	22	4451.5	3496.3
1996	204	23	4657.0	4054.8
1997	198	24	4861.5	4689.6

1990-2 years did not have an impact on the entry and the exit rates, as these years appear in the middle of the ranking list in both Tables[21].

The main findings of this section are as follows: 1) certain four-digit manufacturing industries were characterised with having consistently higher/lower than average *entry rates*, over the 1974-97 period, and certain industries with having consistently higher/lower than average *exit rates*; 2) certain years were characterised with having consistently higher/lower than average *entry rates*, across the four-digit manufacturing industries, and certain years with having consistently higher/lower than average *exit rates* and 3) over the 1974-97 period, the highest entry and exit rates were observed in the years of boom which could indicate that entry and exit may be pro-cyclical.

3.3.6 Length of life of new plants

In order to capture the more dynamic aspect of the entrants' life, it is useful to follow each cohort of entrants that entered during the 1974-97 period, over time, and calculate the proportion of plants that close in each year following entry. This is done by dividing the number of plants that close in each year following entry, by the total number of plants in that cohort in the initial year (Table 3.11[22]). Starting from the year 1974, out of 4365 plants that opened in this year, 11.3% exit in the 1st year following entry, 8.1% in the 2nd year, 6.9% in the 3rd year and this continues until the 23rd year (1997), when the exit rate is equal to 1.6%. It is evident that while almost 50% of entrants exit by the 7th

[21] Although changes in the registration of the plants in 1984 and 1994 resulted in an increase in the entry and the exit rates at the total manufacturing level, it did not have the same impact across the four-digit manufacturing industries. This is evident by comparison between Tables 3.9, 3.10 and 3.2. In Table 3.2 these years were characterised with a high entry and exit rates, while neither in Table 3.9 nor in Table 3.10 do they appear at the top of the ranking list. The reason is that these changes only affected industries with a large number of small plants and not all industries, which implies that the number of the four-digit manufacturing industries affected by the changes were less than the ones not affected. However, those affected were so populated by small plants, which increased the entry and exit rates at the total manufacturing level to a large extent.

[22] Figures in Table 3.11 are calculated using the weighted selected file. The number of plants that opened in a given year is weighted, in order to be a representative of the entire population of plants that opened in that year. Next, based on the information provided in the ARD, regarding the closure year of plants, the proportion of them that close each year following entry, are calculated.

Table 3.11 Closure profile of plants that opened, in the UK manufacturing sector, during the 1974-1997 period (percentages)

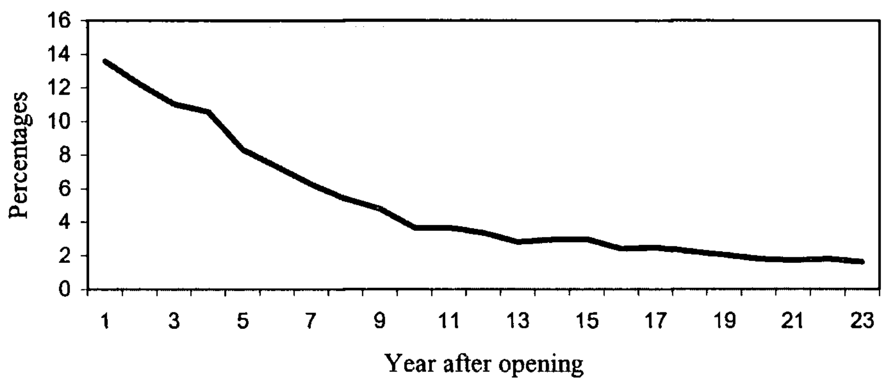
	Year opened										
Year closed	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1974											
1975	11.3										
1976	8.1	8.8									
1977	6.9	5.6	6.7								
1978	9.4	12.0	6.2	6.7							
1979	4.3	6.2	8.1	6.4	13.1						
1980	6.3	6.6	6.6	8.5	12.2	13.2					
1981	5.4	6.6	6.5	11.0	10.3	8.9	9.4				
1982	5.5	7.3	7.4	9.5	10.2	8.2	7.5	7.2			
1983	3.5	3.8	4.4	6.2	6.1	8.9	6.1	8.1	4.5		
1984	4.7	6.3	6.5	7.4	7.1	6.7	9.5	10.0	7.9	7.5	
1985	3.8	3.0	5.5	4.5	4.3	6.2	9.9	10.7	9.7	7.5	14.7
1986	3.5	3.3	3.2	3.2	4.5	6.1	4.6	7.5	8.7	7.4	11.1
1987	2.2	2.0	4.7	3.9	3.0	4.7	8.7	8.5	9.4	8.0	10.4
1988	2.0	2.1	3.0	2.8	3.0	3.9	4.8	4.4	5.0	6.7	9.4
1989	2.6	2.6	3.0	3.5	3.0	4.3	7.6	4.3	5.8	6.8	6.0
1990	1.9	2.5	2.8	3.9	3.8	3.2	4.1	3.6	7.3	7.7	6.2
1991	2.1	2.7	2.0	2.5	1.8	4.1	3.0	5.0	4.1	7.2	6.6
1992	1.6	2.8	1.6	3.0	1.4	1.9	3.7	2.3	3.8	4.5	3.2
1993	1.0	2.0	2.3	1.5	2.1	2.2	3.2	2.3	3.1	4.0	5.0
1994	2.6	3.3	4.6	3.4	4.0	3.5	3.2	4.5	6.9	6.3	3.7
1995	0.9	0.8	1.9	1.7	2.1	1.4	2.0	2.8	1.6	2.0	3.6
1996	1.9	1.7	1.8	2.2	1.7	2.0	2.9	5.9	3.7	3.7	2.1
1997	1.6	1.7	2.5	2.0	1.7	1.9	2.7	3.3	3.2	6.4	3.0
Alive in 1997	6.9	6.5	8.8	6.8	4.6	8.7	7.3	9.5	15.4	14.4	14.8
Total entrants	4365	2608	2246	1669	1492	1048	1235	1096	1011	796	5548

Table 3.11 Continued

	Year opened											
Year closed	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	23.1											
1987	14.1	7.9										
1988	10.2	13.0	6.6									
1989	8.5	11.9	12.2	9.3								
1990	7.8	9.6	9.6	13.5	8.5							
1991	4.6	10.6	14.3	14.3	14.8	10.3						
1992	5.2	7.5	7.2	10.6	13.2	10.2	9.6					
1993	4.1	5.3	9.8	11.1	15.2	17.5	15.0	12.8				
1994	6.6	9.1	8.7	11.9	14.3	16.9	20.0	29.6	25.0			
1995	1.1	5.1	5.5	4.3	5.4	6.9	8.4	12.5	16.4	22.0		
1996	3.2	2.6	6.4	5.4	6.0	10.2	12.5	19.2	13.6	21.2	32.3	
1997	3.2	5.2	5.1	3.6	5.6	9.1	11.4	8.8	10.0	10.6	19.3	41.4
Alive in 1997	8.4	12.3	14.6	16.1	17.0	18.9	23.0	17.2	35.0	46.2	48.4	58.6
Total entrants	3841	1957	3104	2961	4693	2634	2051	4155	2412	10473	9650	3962

year, the proportion of them that make it to 1997 is only 6.9%. This indicates that some 93% of plants have exited, before the end of the period under study. Moving to the year 1975, out of 2608 plants that opened in this year, 8.8% survive for just 1 year, 5.6% for just two years, 12% for just 3 years and this continues until the 22nd year (1997), when 6.5% of plants close. A similar pattern to that in the 1974 cohort is also observed here. As the exit rates tend to decrease, over 50% of entrants (53.1%) exit by the 7th year. Compared to the entrants of adjacent years, entrants of 1984 and 1985 show a relatively higher first year exit rate. This is mainly due to the changes to using the VAT registrations, which happened in 1984 and 1985[23]. As time proceeds, especially towards the 1990's, very intense competition is observed, which shows itself in significantly higher exit rates compared to the previous years. As was explained previously, this could be due partly to change in the plant registrations that occurred post-1992 (the change to IDBR registrations[24]); although it is difficult to separate the two effects. Post-1992, 1st year exit rates increased, to the extent that 41.4% of 1996 entrants exit in the 1st year after entry. In order to get an overall picture, one can take an average of the exit rates (shown in Table 3.11), by year after opening, across all the cohorts (Figure, 3.4).

Figure 3.4 Average exit rate in cohort of entrants in years following entry (percentage of plants)



[23] This is fully explained in Section 3.2. Note, that the VAT register discovered more small plants existed, than were previously in the ARD.
[24] The IDBR discovered far more small plants than were registered, previously. However, the problem associated with matching identities of some existing plants, before and after change into IDBR registration, translated itself into high exit rates in these years.

The 1st year's average exit rate (the first point in Figure 3.4) is calculated by taking an average of all the 1st year exit rates across the entry cohorts (the first line of the columns in Table 3.11). The 2nd year's average exit rate is calculated by taking an average of all the 2nd year exit rates across the entry cohorts (the second line of the columns in Table 3.11). This continues until the 23rd year's average exit rate, which is calculated by getting an average of all the 23rd year exit rates across all the entry cohorts (the only observed 23rd year exit rate in Table 3.11 is for the entrants in 1974).

The average exit rate, shown in Figure 3.4, decreases as the cohorts age. Starting from a high of 13.6% in the 1st year, it reduces gradually, reaching 1.6% in the 23rd year following entry. On average, 47.3% (almost half) of entrants exit before the 5th year. One can see, that although a large number of plants open each year, the majority of them exit shortly after entry.

However, the reduction in exit rates, shown in Table 3.11 and Figure 3.4, are in part a natural consequence. The reason is that out of a fixed number of plants, there will be less remaining as more exits take place. Therefore, the denominator of the ratio (number of plants in the first year when a cohort came into existence) remains constant, while the numerator (number of plants that exit in each year following entry) reduces. Mata *et al.* (1995) studied the life duration of Portuguese manufacturing plants, which were created during the 1983-89 period. They found that more than 20% of them died during their first year, about 50% in the first 4 years, and less than 30% of the entire group survived for 7 years. Dunne, *et al.* (1989) also found that in US manufacturing industries, 39.7% of all firms exited within five years of entry and 70% within ten years of entry.

In order to discover the risk attached to each period following entry, and using the same methodology, entrants are followed over time, but on this occasion hazard rates are calculated (Table 3.12). The hazard rate is defined as the probability of closing in a

Table 3.12 Hazard profile of plants that opened, in the UK manufacturing sector, during the 1974-1997 period (percentages)

	Year opened										
Year closed	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1974											
1975	11.3										
1976	9.2	8.8									
1977	8.5	6.1	6.7								
1978	12.8	14.0	6.7	6.7							
1979	6.6	8.5	9.3	6.9	13.1						
1980	10.5	9.8	8.3	9.8	14.0	13.2					
1981	10.1	10.9	8.9	14.0	13.8	10.2	9.4				
1982	11.3	13.5	11.2	14.1	15.8	10.6	8.3	7.2			
1983	8.2	8.0	7.5	10.8	11.2	12.8	7.4	8.7	4.5		
1984	11.9	14.5	12.0	14.3	14.7	11.0	12.3	11.8	8.2	7.5	
1985	10.9	8.1	11.5	10.3	10.5	11.4	14.7	14.3	11.0	8.1	14.7
1986	11.4	9.6	7.6	8.0	12.2	12.7	7.9	11.8	11.1	8.8	13.0
1987	8.0	6.5	12.1	10.6	9.4	11.1	16.3	15.1	13.6	10.3	14.1
1988	8.1	7.2	8.8	8.7	10.4	10.5	10.7	9.1	8.3	9.6	14.8
1989	11.2	9.7	9.7	11.9	11.3	12.8	19.1	9.9	10.6	10.8	11.1
1990	9.4	10.6	9.8	15.0	16.3	11.2	12.8	9.3	14.9	13.7	12.8
1991	11.2	12.5	7.9	11.2	9.1	16.0	10.6	13.9	9.7	14.9	15.7
1992	10.0	14.8	6.6	15.0	8.2	8.9	14.9	7.6	10.0	10.8	9.1
1993	7.0	12.3	10.4	9.0	12.6	11.0	14.9	8.1	9.3	10.9	15.6
1994	18.9	23.5	23.3	22.1	28.5	20.0	17.6	17.4	22.5	19.2	13.5
1995	7.7	7.2	12.8	14.4	20.8	10.0	13.1	12.8	6.5	7.4	15.3
1996	18.3	17.2	13.4	21.2	21.0	16.2	22.2	31.7	16.6	15.2	10.5
1997	19.2	20.7	22.2	25.3	26.4	17.7	27.0	25.9	17.4	30.7	16.8

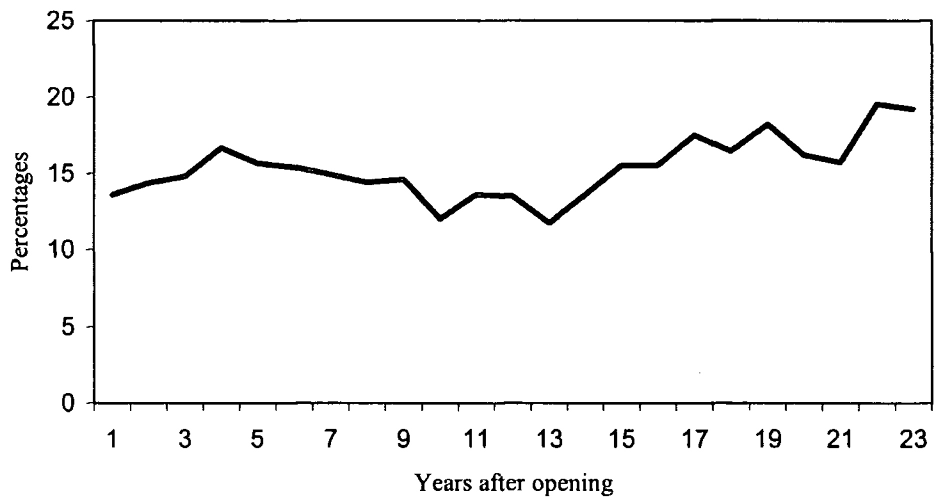
Table 3.12 Continued

	Year opened											
Year closed	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	23.1											
1987	18.3	7.9										
1988	16.2	14.1	6.6									
1989	16.2	15.0	13.0	9.3								
1990	17.6	14.3	11.8	14.9	8.5							
1991	12.8	18.5	19.9	18.6	16.1	10.3						
1992	16.3	16.0	12.5	16.8	17.2	11.3	9.6					
1993	15.3	13.3	19.6	21.1	23.9	22.1	16.6	12.8				
1994	29.2	26.5	21.6	28.8	29.6	27.3	26.5	34.0	25.0			
1995	6.9	20.4	17.5	14.6	15.8	15.2	15.2	21.7	21.9	22.0		
1996	21.4	12.9	24.4	21.5	21.1	26.7	26.7	42.5	23.3	27.2	32.3	
1997	27.4	29.7	25.8	18.2	24.9	32.4	33.1	33.8	22.1	18.7	28.5	41.4

specific time period, having survived up to that time. The difference between the two measures is that the denominator of the hazard rate is the total number of surviving plants at the beginning of each time period[25].

There is no systematic pattern discovered in the hazard rates, although a careful examination of the figures reveals that hazard rates tend to increase towards the 1990s, especially in the late 1990s. In order to get an overall picture, one can get an average of the hazard rates (shown in Table 3.12) across the cohorts, by each year after opening (Figure 3.5).

Figure 3.5 Average hazard rate of closure by years after opening



The mean by which each point, in Figure 3.5, is calculated is similar to that used in Figure 3.4. The 1st year's average hazard rate is calculated by getting an average of the 1st row of the column in Table 3.12; the 2nd year's average hazard rate, by getting an average of the 2nd row of the columns; and this continues until the 23rd year's average hazard rate, by getting an average of the 23rd row of the columns. Starting from 13.6% in the 1st year following entry (Figure, 3.5), hazard rates do not show a systematic pattern until the 14th year after entry. However, after the 14th year the hazard rate

[25] The denominator of the figures in Table 3.11 is the total number of entrants in the year they entered.

increases, reaching a high of 19.2% in the 23rd year following entry. This pattern could be due, partly, to the presence of high competition and change to IDBR registration, which resulted in higher hazard rates in those years.

However, this result is rather surprising and controversial, if compared with previous findings found in the literature. Boeri and Bellmann (1995) and Mata *et al.* (1995) both found that the hazard rate of entrants decreased with their age. This refers to the impact of learning-by-doing (associated with age), on plant survival[26]. In Geroski (1995), this is represented as a 'stylised' fact, that 'both firm size and age are correlated with the survival of entrants'. He explains that turnover and exit are the by-products of the process in which firms adjust themselves to the turbulent environment, through information acquisition. At the same time, not only is information costly and some entrants underinvest in information gathering, but also in the presence of a changing market environment, the type of actions, which they need to take in order to survive, also changes. This, according to Geroski (*op. cit*), shows clearly that the ability of entrants to learn about their changing environment directly affects their growth and, consequently, their survival. Therefore, the slower their process of learning, the more likely they are to decline in size and eventually exit. At the same time, as learning comes with the age of plants, this shows the impact of age on the growth and the likelihood of survival.

The findings of this section are as follows: 1) on average, 43.7% (almost half) of entrants survived for less than five years; 2) exit rates on average fall as a cohort ages, which is in part due to the high closure of plants in the first few years after entry and 3) no clear pattern was found in the hazard rates in the first 14 years after entry, although there is some evidence that it increased afterwards. This increase may be due, partly, to

[26] This effect will be investigated further in Section 5.3.4.2, when studying the impact of initial size, current size and age on the plants' likelihood of closure.

the economic boom and high competition in the late 1990s. However, this finding indicates that there was no specific risk attached to the first 14 years following entry.

3.3.7 Distribution of closures by age

An alternative way to capture the dynamics of plant opening and closure is to calculate the age of the plants that close in a given year, based on the year they opened. Following this we can also calculate the contribution of plants of various ages to total closure in that year. This is done, separately, for the closures of each year, over the 1974-97 period (Table 3.13).

Taking the year 1997, out of 2651 closures[27] that occurred in this year, 17.5% opened in 1996, 25.5% opened in 1995, 15.0% opened in 1994, while 11.4% opened before 1974. Sudden increases in the closure of one-year-old plants, in 1984-85 and 1993, are again due to the changes that happened in the ARD, as explained in Section 3.2. The competitive environment of the late 1990s resulted in a very high closure rate of young (especially one year old) plants. This is evident by examining the proportion of one-year-old plants that closed in 1995 and 1996, which were 50.9% and 41.4%, respectively. The evidence on the age distribution of closed plants is varied: in some years (for example 1983) one year old plants contribute least to the total closure and in some other years (for example 1995) they contribute most.

[27] This figure is calculated using the weighted selected file.

Table 3.13 Distribution of exit by the year opened, for the UK manufacturing industries, over the 1974-97 period (percentages)

	Year closed										
Year opened	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1974	18.7	14.9	14.0	16.8	10.8	10.6	9.0	9.3	7.0	7.7	5.0
1975		12.5	7.8	10.5	9.5	8.5	6.9	7.6	6.3	8.4	2.8
1976			9.0	7.4	7.6	6.6	5.4	6.0	5.4	5.4	4.8
1977				6.4	6.3	5.7	5.6	7.0	5.1	5.4	1.9
1978					12.8	8.9	5.9	6.4	5.3	3.5	2.8
1979						7.1	3.9	3.2	4.8	4.2	1.9
1980							5.4	4.4	4.8	7.4	5.3
1981								4.0	6.0	5.5	4.0
1982									3.1	4.8	3.3
1983										3.8	2.5
1984											35.0
1985											
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993											
1994											
1995											
1996											
Open before 1974	81.3	72.6	69.1	58.9	53.1	52.5	58.0	52.1	52.1	43.9	30.8
Total closure	2651	1842	1676	1769	1528	1963	2138	2003	1435	1572	2337

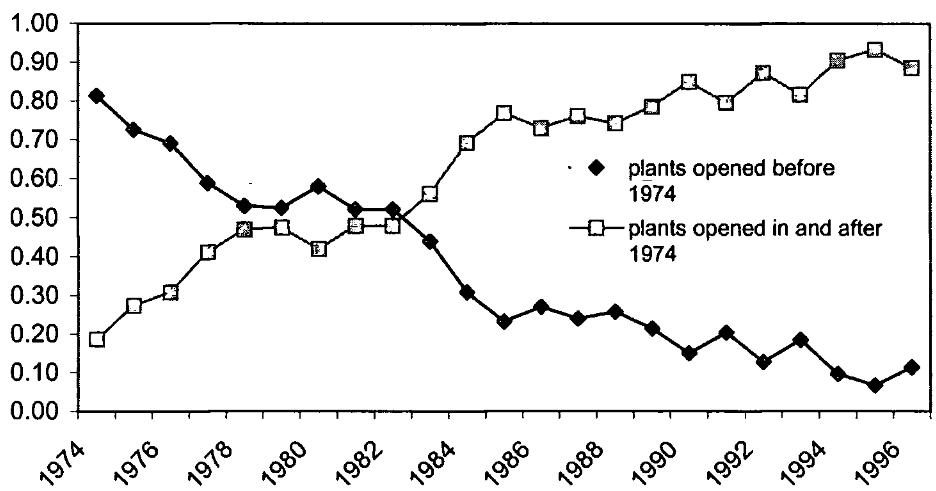
Note: Figures are calculated using the weighted selected file.

Table 3.13 Continued

	Year closed											
Year opened	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974	4.7	2.2	4.0	3.3	2.6	2.7	2.2	1.2	2.1	0.8	1.1	1.1
1975	2.4	2.3	3.4	1.9	2.3	1.3	2.7	0.9	1.8	0.4	0.3	0.5
1976	2.7	4.7	2.7	2.5	1.9	1.4	1.5	1.3	1.2	0.8	0.4	0.6
1977	1.4	2.2	2.3	2.1	1.5	1.4	1.8	0.7	0.8	0.6	0.2	0.5
1978	2.3	1.7	1.6	1.6	1.5	1.0	0.9	1.3	1.3	0.5	0.2	0.3
1979	2.0	1.8	1.4	1.6	1.1	1.1	1.0	0.3	0.7	0.3	0.2	0.2
1980	2.2	4.1	1.9	3.5	1.5	1.5	1.8	1.1	0.8	0.4	0.4	0.6
1981	2.9	3.9	2.3	1.9	1.5	1.5	1.0	0.8	1.2	0.6	0.3	0.5
1982	2.9	3.8	2.7	1.5	2.2	1.8	1.2	0.8	1.0	0.5	0.4	0.8
1983	1.9	2.5	3.5	1.6	1.7	1.1	1.5	1.2	0.7	0.5	0.2	0.7
1984	14.3	16.1	12.9	8.8	7.1	7.1	3.1	2.3	3.3	2.0	0.9	2.0
1985	37.0	19.4	14.9	7.2	7.0	5.8	5.0	3.3	3.3	2.4	0.9	2.2
1986		8.3	11.9	7.5	6.2	5.6	5.1	3.5	3.8	2.4	0.9	1.5
1987			10.6	16.2	11.3	12.0	7.5	8.5	4.1	3.2	1.7	2.5
1988				13.0	14.8	13.6	8.9	6.6	4.4	2.3	1.5	1.6
1989					14.5	15.3	14.6	9.7	7.6	3.8	1.8	2.5
1990						10.7	10.3	12.5	7.7	2.5	2.2	2.9
1991							9.4	9.9	5.8	2.3	1.9	2.4
1992								21.4	11.4	7.1	4.2	3.5
1993									18.7	6.1	2.6	3.7
1994										50.9	29.7	15.0
1995											41.4	25.5
1996												17.5
Open before 1974	23.2	27.0	23.9	25.8	21.4	15.0	20.4	12.7	18.4	9.6	6.7	11.4
Total closure	2404	1860	1942	2115	2741	2541	2094	2486	3229	4520	7521	9369

Next, one can add up the percentages in each column of Table 3.13, in order to get the contribution of plants that opened in and after 1974, to total closures in each year. This way one can discover how the proportion changes over time, in comparison to the contribution of those plants that opened prior to 1974. These proportions are depicted according to year in Figure 3.6. As can be seen, plants that opened prior to 1974 contributed more to total exit until 1983 (10 years into the study time period), when the relationship reverses and the newer entrants contribute more to the total exit. The trend is a natural outcome, as year by year there are fewer remaining plants from the fixed number that entered before 1974. However, Figure 3.6 shows how long it takes for the exiting of the new entrants to overtake those of the more established plants. This shows the high level of dynamics in the UK manufacturing industries and the increasing importance of entrants, in terms of numbers, as compared with older plants.

Figure 3.6 Contribution of plants that entered pre-1974 in comparison to those that entered post-1974 to total plant closure against year



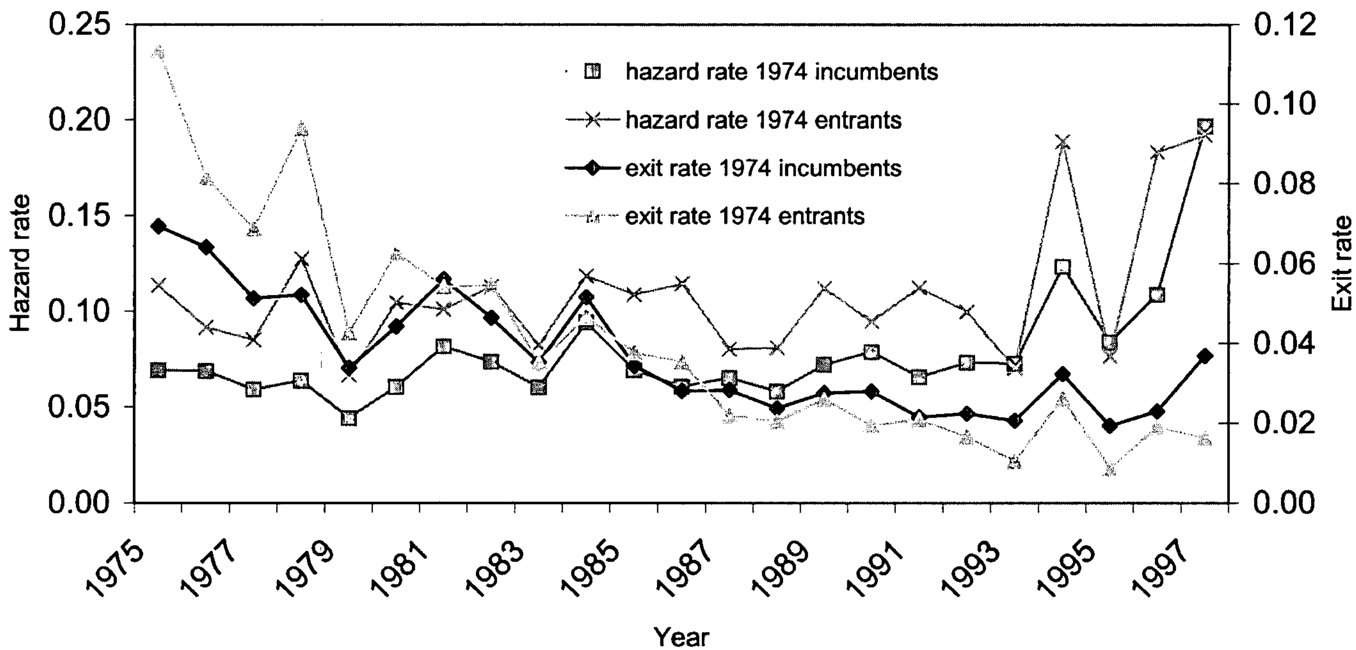
3.3.8 Comparing length of life of entrants with incumbents

In this section the experience of entrants for a given year in the years following entry is compared with the experience of those plants that existed at the beginning of the year (incumbents). A reason for carrying out this exercise is to find out, in the years following entry, whether incumbents possess any advantage over entrants, in terms of having a lower hazard rate or exit rate. Take the year 1974 as an example[28], total plants in this year are divided into two sub-groups: new entrants and incumbents. Then, these sub-groups are followed over time (the process is the same as in Tables 3.11 and 3.12) and compared, in terms of their exit rate and hazard rate, in each year following entry. The exit rates and hazard rates of the two sub-groups are depicted against the year after opening in Figure 3.7.

Comparing the exit rate of plants that opened in 1974 with the exit rate of plants that opened prior to 1974, one can see that the exit rate of both groups decreases over time, although it is more gradual for the incumbents. Starting from a value of 0.113, the exit rate of entrants stays higher than that of the incumbents, until the 10th year after entry. However, the difference decreases over time, but from 1987 (the 13th year after entry) the relationship reverses and the exit rate of entrants falls below that of the incumbents. This relationship is due, partly, to the high closure rate of entrants in the initial years after entry. That is the number of survivors falls rapidly over time, hence their exit rate drops even more than that of the 1974 incumbents.

[28]There is no specific reason behind the choice of years. However, the experience of entrants to that of incumbents, in the years following entry, could be different, depending on the year. Therefore, to avoid any bias, 1974 is picked as an early year from the period under study and 1985, as a middle year.

Figure 3.7 Comparison between hazard rate and exit rate of plants that opened in 1974, relative to those that were in operation at the beginning of 1974, in each year following entry

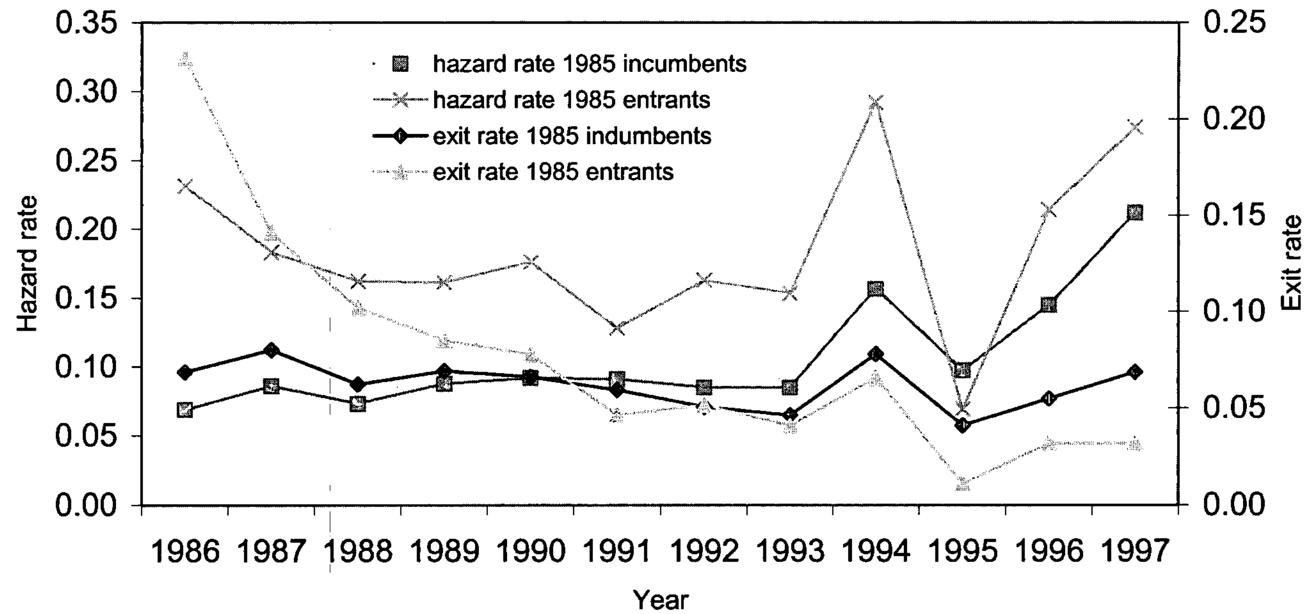


Trends in the hazard rates are not very clear, since for both groups it is increasing over time (specially for the incumbents). However, the entrants in 1974 face a higher hazard (risk) of closure in comparison to the 1974 incumbents in any year after 1974 (except for 1993, 1995 and 1997). This means that having survived up to any point in time, 1974 entrants face a higher risk of closure compared to the plants that opened before 1974. This is clear in Figure 3.7, as the line showing 1974 entrants' hazard rate lies well above that of the incumbents.

The same exercise is repeated for the 1985 entrants and incumbents (Figure 3.8). Similar trends are observed for the exit rates and the hazard rates. As the exit rates decrease over time, it is more gradual for the 1985 incumbents. Starting from 0.231, the exit rate of the 1985 entrants stays higher than that of the 1985 incumbents until 1991 (the 6^{th} year after entry). Post-1993, the exit rate of entrants falls below that of the incumbents and remains lower afterwards. With regards to the hazard rates, the increase is obvious for the 1985 incumbents, while there is no clear trend in the hazard rate for the 1985 entrants. Starting from a high of 0.231, the hazard rate of entrants remains higher than that of the incumbents in any year post-1985 (except for 1995).

A common pattern was observed in both examples. In the first few years after entry, entrants had a higher exit rate, relative to those plants that existed at the beginning of the entry period. However, following the initially high closure of entrants, their exit rate decreased sharply and, finally, dropped below that of the incumbents. On the other hand, in every year following their entry (except those years mentioned), the entrants faced a higher risk of closure relative that of the incumbents. This, obviously, shows the clear disadvantage that the entrants face relative to the incumbents, which increases their risk of closure in the subsequent years. As is explained in the literature, this advantage for incumbents comes from two aspects: 1) the strategic implications of

Figure 3.8 Comparison between hazard rate and exit rate of plants that opened in 1985, relative to those that were in operation at the beginning of 1985, in each year following entry



having a first mover advantage and 2) the different asymmetries that are created by incumbents, such as cost asymmetries, capacity asymmetries, brand loyalty and all the other factors that affect a firm's profits. These two aspects, in total, create what is known as the value of incumbency (Freshtman, 1996). As a result, the new plants, in any period after entry, face disadvantages relative to the incumbents. However, the associated disadvantage reduces as they age.

3.3.9 Growth of the surviving plants

In order to characterise the post-entry experience of the surviving plants, this section first looks at the average size of new plants (measured in real gross value added), in each year following entry. By following entrants for each year, over the 1974-97 period, the average real GVA[29] (real gross value added) of the surviving plants is considered for each year following entry (Table 3.14). As can be seen from Table 3.14, the average size of the surviving plants tends to increase the longer they stay in operation (although there are decreases in some years). Taking 1974 as an example, the average size of a plant that opened in this year (measured in terms of real GVA) is £43,000, which steadily increases to an average size of £144,000 in 1997.

To get an overall picture of the post-entry growth of plants, one can calculate the average of the average size of the surviving plants (shown in Table 3.14), across all the entry cohorts, in each year following entry. The calculated average sizes are plotted against year after opening in Figure 3.9. The 1st year's average size (shown in Figure 3.9) is calculated by getting an average of the first row of the columns across all the cohorts in Table 3.14, the 2nd year's average size is the average of the second row of the columns, and this continues until the 23rd year. Having an average real GVA of £43,000

[29] Real gross value added is calculated, as real gross output minus intermediate output. The base year in this case is 1990.

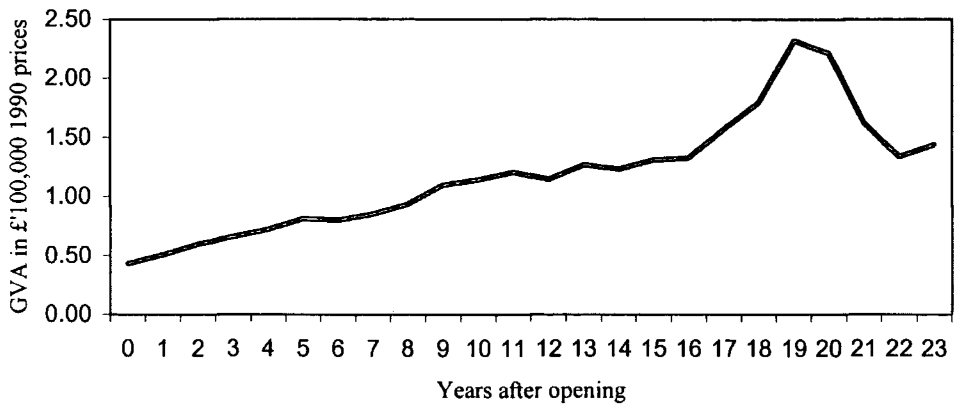
Table 3.14 Average gross value added of surviving plants, 1974-1997 (£ hundred thousand), 1990 prices

	Year opened											
Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1974	0.43											
1975	0.42	0.50										
1976	0.56	0.45	0.55									
1977	0.55	0.47	0.59	0.56								
1978	0.54	0.47	0.49	0.39	0.27							
1979	0.57	0.48	0.64	0.44	0.27	0.54						
1980	0.51	0.55	0.55	0.46	0.41	0.59	0.50					
1981	0.50	0.48	0.47	0.46	0.46	0.63	0.41	0.47				
1982	0.53	0.54	0.55	0.50	0.57	0.73	0.43	0.36	0.49			
1983	0.62	0.61	0.62	0.54	0.64	0.81	0.48	0.41	0.41	0.54		
1984	1.09	1.25	1.06	0.89	1.08	1.72	1.00	0.67	0.67	0.65	0.27	
1985	0.98	0.99	0.79	0.71	1.03	1.05	0.85	0.84	0.77	0.65	0.89	0.26
1986	0.72	0.79	0.59	0.56	0.92	0.86	0.57	0.52	0.59	0.51	0.75	0.47
1987	0.85	0.87	0.69	0.78	0.97	1.09	0.82	0.61	0.74	0.59	0.87	0.60
1988	0.97	1.05	0.67	0.75	1.09	1.16	1.11	0.70	0.82	0.74	0.95	0.80
1989	1.08	1.35	0.77	1.03	1.35	1.54	1.62	0.81	0.93	0.83	1.06	0.88
1990	1.11	1.08	0.75	1.16	1.20	1.68	1.36	0.78	0.84	0.94	1.01	0.95
1991	0.99	1.27	0.63	1.12	1.11	1.72	1.20	0.73	0.84	0.86	1.08	0.92
1992	1.04	1.35	0.67	1.50	1.02	1.96	1.04	0.72	0.89	0.88	0.97	0.95
1993	1.64	1.97	0.93	1.47	1.72	1.74	1.26	1.09	1.27	1.62	1.22	1.16
1994	1.44	3.00	0.97	2.13	1.48	1.38	1.29	1.57	1.27	1.04	1.48	1.22
1995	1.57	2.97	1.57	3.56	2.82	2.68	2.23	1.83	1.74	1.60	2.36	1.87
1996	1.29	2.63	0.74	3.30	1.90	2.20	1.14	1.38	1.09	0.83	1.19	1.21
1997	1.44	1.39	0.68	3.69	2.10	1.32	0.58	0.79	0.79	1.16	1.65	1.34

Table 3.14 Continued

	Year opened											
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	0.41											
1987	0.51	0.42										
1988	0.61	0.47	0.36									
1989	0.74	0.60	0.43	0.32								
1990	0.74	0.57	0.44	0.38	0.40							
1991	0.66	0.50	0.54	0.40	0.40	0.50						
1992	0.73	0.57	0.63	0.47	0.46	0.63	0.24					
1993	1.06	0.85	1.30	0.70	0.81	0.92	0.58	0.42				
1994	1.12	0.79	1.04	0.61	0.75	1.48	1.01	0.90	0.49			
1995	1.78	1.03	1.47	0.97	1.13	1.43	0.84	1.49	0.34	0.57		
1996	1.03	1.17	1.63	0.79	0.56	1.49	0.89	0.82	0.22	0.75	0.38	
1997	1.62	0.91	1.63	0.50	0.58	1.28	0.44	0.55	0.21	0.44	0.29	0.49

Figure 3.9 Average size of entrants, measured in real gross value added, in years following entry



in the initial year (as shown in Figure 3.9) the size of the surviving plants tends to increase following entry. It reaches the average size of £221,000, by the 20th year, and decreases afterwards.

In Section 3.3.6 it was found that, on average, about 50% of entrants leave before the 5th year. However, Figure 3.9 shows that despite the high mortality rate, those that survive tend to grow significantly in size, as time progresses. This being so, it is useful to consider the extent to which the growth of the surviving plants increases the overall size (measured in real gross value added) of the entry cohort to which they belong. Two factors affect the size of a given cohort over time: the closure of plants tends to reduce the number of plants in that cohort and, therefore, its overall size; while the growth of the surviving plants tends to increase the cohort's size. Whether the overall impact is a reduction or increase in size of that cohort depends on the magnitude of these forces. To test this, one needs to follow each cohort of entrants over time and find the aggregate size of the cohort, as a percentage of its size in the year it came into existence (Table 3.15)[30]. One can see that size of the cohorts tend to decrease in the majority of cases as

[30] Note, that in Table 3.15 the overall size of a given cohort, in each year following entry, is divided by the overall size of the same cohort, in the year it came into existence. The overall size is calculated by adding up the real gross value added of all the plants belonging to that cohort. This differs from Table 3.14 in that, Table 3.14 looked at the average size of the surviving plants belonging to a given cohort, in each year following entry.

Table 3.15 Gross value added of surviving plants as a percentage of the gross value added in the initial year, 1974-97

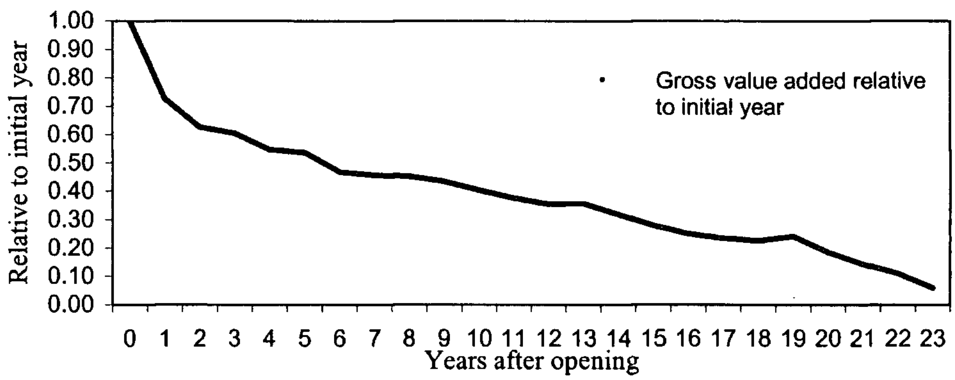
	Year opened											
Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1974	1.00											
1975	0.90	1.00										
1976	0.89	1.02	1.00									
1977	0.78	0.79	1.19	1.00								
1978	0.62	0.62	0.67	0.81	1.00							
1979	0.70	0.66	0.90	0.90	0.74	1.00						
1980	0.53	0.64	0.68	0.81	0.87	1.25	1.00					
1981	0.47	0.50	0.54	0.68	0.85	1.10	0.84	1.00				
1982	0.46	0.50	0.58	0.65	0.90	1.16	0.76	0.90	1.00			
1983	0.48	0.52	0.58	0.61	0.87	1.08	0.83	0.92	0.95	1.00		
1984	0.51	0.57	0.55	0.53	0.88	1.24	0.92	0.84	0.76	0.89	1.00	
1985	0.41	0.41	0.39	0.38	0.78	0.71	0.62	0.84	0.80	0.79	0.31	1.00
1986	0.38	0.41	0.35	0.39	0.75	0.71	0.52	0.68	0.79	0.78	0.30	0.25
1987	0.39	0.41	0.34	0.49	0.66	0.76	0.62	0.64	0.77	0.72	0.25	0.27
1988	0.39	0.39	0.29	0.40	0.65	0.68	0.70	0.65	0.68	0.74	0.22	0.26
1989	0.42	0.52	0.34	0.51	0.73	0.78	0.93	0.74	0.71	0.79	0.27	0.28
1990	0.37	0.37	0.28	0.48	0.54	0.70	0.64	0.55	0.54	0.70	0.19	0.23
1991	0.30	0.37	0.21	0.40	0.45	0.62	0.46	0.46	0.49	0.58	0.17	0.20
1992	0.24	0.28	0.19	0.37	0.33	0.55	0.30	0.31	0.34	0.41	0.13	0.15
1993	0.28	0.31	0.17	0.31	0.39	0.38	0.27	0.33	0.46	0.47	0.15	0.16
1994	0.27	0.40	0.18	0.38	0.36	0.29	0.31	0.47	0.45	0.35	0.16	0.14
1995	0.17	0.24	0.15	0.32	0.28	0.24	0.22	0.27	0.38	0.32	0.13	0.12
1996	0.13	0.19	0.08	0.31	0.20	0.20	0.13	0.18	0.19	0.17	0.07	0.07
1997	0.06	0.09	0.06	0.15	0.07	0.11	0.03	0.03	0.07	0.12	0.03	0.03

Table 3.15 Continued

	Year opened											
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	1.00											
1987	0.51	1.00										
1988	0.49	0.83	1.00									
1989	0.50	0.87	0.73	1.00								
1990	0.39	0.67	0.53	0.55	1.00							
1991	0.33	0.50	0.51	0.46	0.60	1.00						
1992	0.27	0.38	0.38	0.33	0.46	0.65	1.00					
1993	0.30	0.32	0.44	0.28	0.43	0.51	0.34	1.00				
1994	0.30	0.33	0.40	0.30	0.38	0.80	0.52	0.60	1.00			
1995	0.22	0.22	0.32	0.21	0.32	0.41	0.16	0.42	0.52	1.00		
1996	0.14	0.24	0.33	0.17	0.15	0.42	0.16	0.19	0.26	0.59	1.00	
1997	0.08	0.12	0.20	0.09	0.07	0.20	0.03	0.05	0.22	0.21	0.74	1.00

the cohort ages. Taking the 1974 cohort as an example, its overall size (in terms of real gross value added) in 1975 was 90% of its size in 1974. In 1976 it was 89% and this continued until 1997, when its overall size was only about 6% of its size in 1974. In order to get an overall picture, one needs to take an average of the ratios, shown in Table 3.15, across all the entry cohorts, in each year following entry (Figure 3.10[31]).

Figure 3.10 Average GVA across all cohorts from 1974-97 in each year after opening (numbers are expressed as a percentage of the initial year GVA)



One can see that, on average, the overall size (measured in real GVA) of a given cohort, which entered between 1974-97, tends to decrease as it ages. This clearly shows that, as time proceeds, the negative impact on the overall size (due to the closure of plants) is greater than the positive impact on the overall size (due to the growth of the surviving plants).

In order to find out how the share of the cohorts changes over time the associated shares (relative to total manufacturing real GVA and plant numbers) are calculated for each cohort. Note, these shares are also divided by the first year's shares, in order to determine whether they have increased or decreased in relative terms (Table 3.16 and 3.17).

[31] Figure 3.10 is obtained from Table 3.15 going through exactly the same procedure, as that used in Figure 3.9. The 1st year's figure (plotted in Figure 3.10) is calculated, by getting an average of the 1st row of the columns in Table 3.15; the 2nd year's figure, by getting an average of the 2nd second rows of the columns; and this continues until the 23rd year's figure, by getting an average of the 23rd row of the columns.

Table 3.16 Share of the number of plants as a percentage of the initial year, 1974-97

	Year opened											
Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1974	1.00											
1975	0.99	1.00										
1976	0.72	1.10	1.00									
1977	0.64	0.82	1.11	1.00								
1978	0.57	0.71	0.82	1.25	1.00							
1979	0.62	0.75	0.89	1.29	0.75	1.00						
1980	0.59	0.71	0.86	1.21	0.66	1.26	1.00					
1981	0.55	0.65	0.82	1.07	0.58	1.06	1.04	1.00				
1982	0.53	0.60	0.77	0.96	0.52	1.01	0.92	1.23	1.00			
1983	0.48	0.57	0.70	0.85	0.46	0.86	0.93	1.12	1.14	1.00		
1984	0.25	0.26	0.34	0.39	0.24	0.40	0.43	0.55	0.49	0.65	1.00	
1985	0.27	0.28	0.39	0.42	0.26	0.45	0.40	0.52	0.53	0.68	0.11	1.00
1986	0.35	0.38	0.49	0.59	0.30	0.58	0.54	0.73	0.72	0.91	0.14	0.15
1987	0.29	0.32	0.39	0.50	0.24	0.47	0.43	0.55	0.54	0.70	0.09	0.12
1988	0.25	0.25	0.33	0.41	0.20	0.38	0.34	0.48	0.42	0.55	0.07	0.08
1989	0.19	0.20	0.26	0.29	0.14	0.26	0.24	0.36	0.30	0.41	0.06	0.06
1990	0.20	0.21	0.27	0.30	0.15	0.26	0.24	0.34	0.31	0.39	0.06	0.06
1991	0.18	0.19	0.25	0.26	0.13	0.23	0.20	0.32	0.28	0.37	0.05	0.05
1992	0.15	0.14	0.22	0.19	0.11	0.19	0.16	0.22	0.19	0.26	0.04	0.04
1993	0.12	0.12	0.16	0.19	0.09	0.17	0.14	0.18	0.21	0.19	0.04	0.04
1994	0.11	0.08	0.12	0.12	0.07	0.12	0.12	0.14	0.16	0.17	0.03	0.03
1995	0.06	0.05	0.06	0.06	0.03	0.05	0.05	0.06	0.10	0.09	0.02	0.01
1996	0.05	0.04	0.07	0.06	0.03	0.05	0.05	0.06	0.07	0.10	0.02	0.01
1997	0.03	0.06	0.09	0.04	0.01	0.07	0.04	0.03	0.06	0.07	0.01	0.01

Table 3.16 Continued

	Year opened											
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	1.00											
1987	0.38	1.00										
1988	0.30	0.72	1.00									
1989	0.20	0.46	0.47	1.00								
1990	0.19	0.45	0.41	0.57	1.00							
1991	0.18	0.39	0.33	0.47	0.61	1.00						
1992	0.14	0.27	0.22	0.30	0.42	0.53	1.00					
1993	0.12	0.18	0.14	0.19	0.25	0.33	0.16	1.00				
1994	0.09	0.15	0.12	0.18	0.19	0.25	0.11	0.22	1.00			
1995	0.04	0.08	0.07	0.08	0.10	0.12	0.04	0.09	0.72	1.00		
1996	0.04	0.07	0.06	0.08	0.10	0.12	0.04	0.07	0.55	0.44	1.00	
1997	0.02	0.07	0.06	0.10	0.07	0.11	0.02	0.05	0.77	0.41	0.71	1.00

Table 3.17 Share of the gross value added as a percentage of the initial year, 1974-97

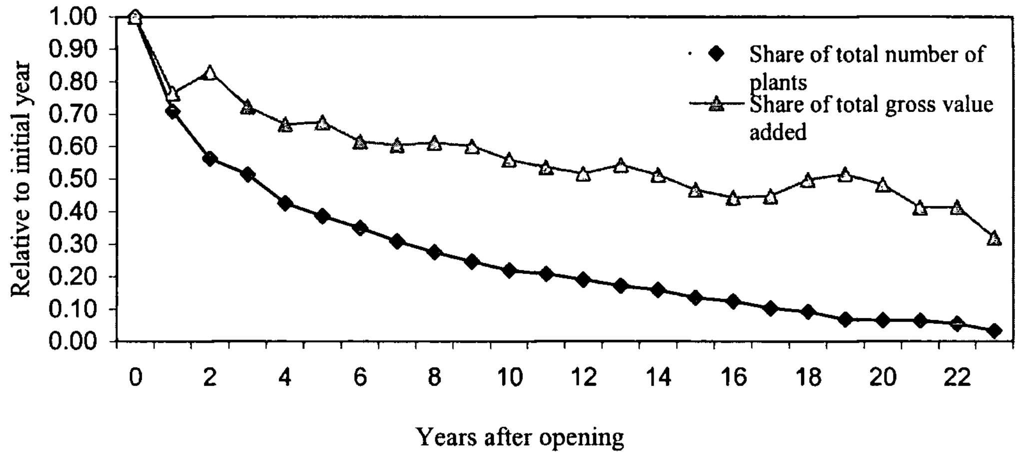
	Year opened											
Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1974	1.00											
1975	0.92	1.00										
1976	0.80	0.89	1.00									
1977	0.75	0.75	1.29	1.00								
1978	0.74	0.72	0.89	0.99	1.00							
1979	0.86	0.79	1.25	1.14	0.76	1.00						
1980	0.84	0.99	1.20	1.31	1.15	1.60	1.00					
1981	0.82	0.85	1.05	1.22	1.23	1.55	0.92	1.00				
1982	0.81	0.84	1.12	1.15	1.31	1.63	0.83	0.91	1.00			
1983	0.81	0.85	1.09	1.05	1.23	1.47	0.89	0.89	0.92	1.00		
1984	0.70	0.76	0.85	0.74	1.02	1.38	0.80	0.67	0.60	0.74	1.00	
1985	0.72	0.70	0.76	0.68	1.14	1.00	0.68	0.84	0.81	0.82	0.39	1.00
1986	0.72	0.77	0.75	0.77	1.21	1.10	0.64	0.75	0.88	0.89	0.42	0.27
1987	0.69	0.71	0.68	0.90	0.98	1.10	0.70	0.65	0.79	0.76	0.33	0.27
1988	0.67	0.65	0.56	0.71	0.93	0.95	0.76	0.64	0.68	0.75	0.27	0.26
1989	0.57	0.68	0.51	0.70	0.82	0.85	0.79	0.58	0.54	0.63	0.27	0.22
1990	0.62	0.59	0.52	0.83	0.76	0.96	0.67	0.53	0.53	0.70	0.23	0.22
1991	0.57	0.69	0.46	0.78	0.71	0.97	0.56	0.52	0.54	0.67	0.24	0.22
1992	0.55	0.63	0.48	0.87	0.63	1.02	0.43	0.42	0.45	0.56	0.21	0.20
1993	0.51	0.55	0.34	0.60	0.61	0.57	0.32	0.35	0.49	0.52	0.20	0.17
1994	0.39	0.55	0.28	0.55	0.43	0.33	0.28	0.38	0.37	0.30	0.17	0.12
1995	0.35	0.48	0.33	0.66	0.48	0.39	0.28	0.31	0.44	0.38	0.19	0.13
1996	0.35	0.52	0.23	0.89	0.45	0.45	0.23	0.28	0.30	0.29	0.15	0.11
1997	0.32	0.48	0.37	0.83	0.30	0.49	0.11	0.11	0.21	0.38	0.12	0.10

Table 3.17 Continued

	Year opened											
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1974												
1975												
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986	1.00											
1987	0.47	1.00										
1988	0.43	0.80	1.00									
1989	0.35	0.66	0.57	1.00								
1990	0.34	0.63	0.52	0.69	1.00							
1991	0.33	0.54	0.57	0.66	0.68	1.00						
1992	0.33	0.50	0.51	0.57	0.64	0.77	1.00					
1993	0.29	0.33	0.48	0.38	0.47	0.49	0.27	1.00				
1994	0.22	0.26	0.33	0.32	0.33	0.59	3.23	0.46	1.00			
1995	0.23	0.25	0.38	0.31	0.38	0.42	0.14	0.45	0.73	1.00		
1996	0.20	0.38	0.54	0.34	0.26	0.60	0.20	0.29	0.50	0.82	1.00	
1997	0.23	0.35	0.64	0.37	0.23	0.58	0.08	0.16	0.85	0.56	0.69	1.00

Therefore, Table 3.16 shows each cohort's share of the total number of manufacturing plants, in each year following entry, divided by its share in the first year the cohort came into existence. Table 3.17 repeats this exercise for real GVA shares rather than plant numbers. Figure 3.11[32] shows the average of the ratios, shown in Table 3.16 and 3.17, for each year since their opening, across all entry cohorts.

Figure 3. 11 Share of the surviving plants vis-à-vis all manufacturing plants: GVA share and number of plants (as a percentage of the initial year, 1974-97)

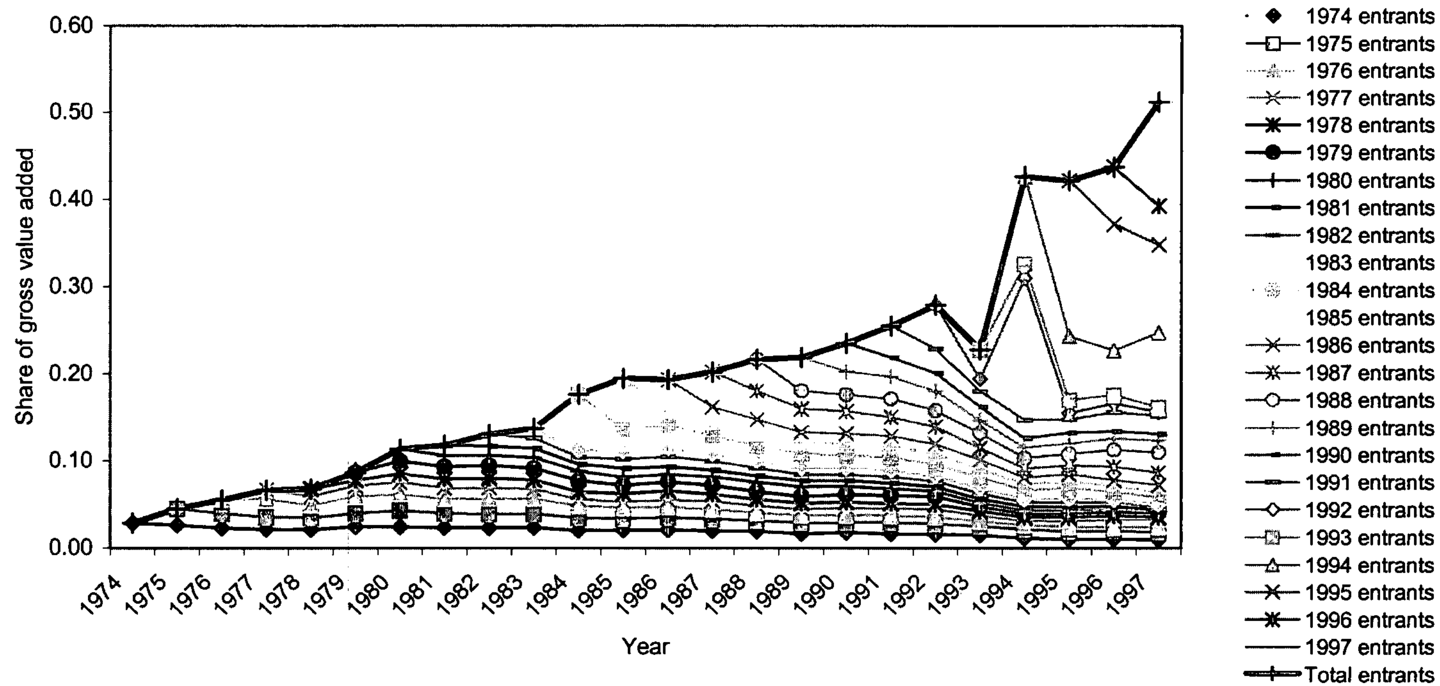


One can see that, on average, the share of a cohort (from the total manufacturing number of plants and real GVA); relative to its share in the first year, decreases as it ages. However, the decrease in its share from the total manufacturing plants is more than the decrease in its share from the total manufacturing real GVA. This shows that small plants (in terms of real GVA) exit first.

Finally, it is possible to measure the cumulative share (of the total manufacturing real GVA) of the cohorts of entrants, in a given year, over the 1974-97 period (shown in Figure 3.12). This is done, by adding up the share of the individual cohorts, from total manufacturing real GVA, in a given year. Over time, entrants contribute more and more

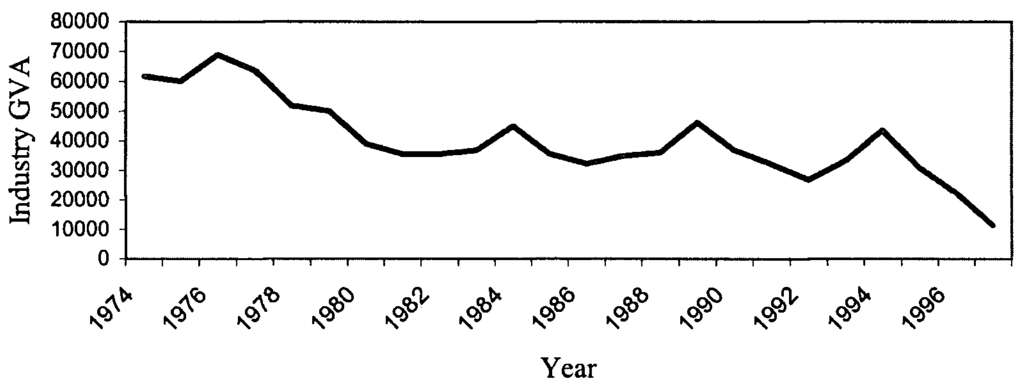
[32] The process, in order to get the data for Figure 3.11, is the same as that for Figure 3.10 and 3.9. The squares were obtained from figures in Table 3.16 and the triangles from figures in Table 3.17.

Figure 3.12 The cumulative share of entrants from the total manufacturing gross value added



to the total manufacturing GVA (this is evident in Figure 3.12 from the bolded black line). However, the associated share for each cohort decreases. By 1997, entrants account for some 51% of the total manufacturing's GVA, while the remaining 49% of GVA belongs to those plants that entered before 1974. Figure 3.12 can be better understood, when looked at in conjunction with Figure 3.13 and Table 3.15. Figure 3.13 shows the real GVA of the manufacturing industries as a whole, over the 1974-97 period.

Figure 3.13 Total manufacturing real GVA



In order to analyse Figure 3.12, one needs to consider how this Figure and both Figure 3.13 and Table 3.15 were calculated. Therefore, we define GVA_{ct} as the real gross value added of a given cohort in year t; GVA_{c1}, as the real gross value added of that cohort in the year it entered; GVA_{indt}, as real gross value added of the manufacturing industries in year t; and GVA_{ind1}, as real gross value added of the manufacturing industries in the initial year that the cohort entered. The numbers in Table 3.15 were obtained by calculating GVA_{ct}/GVA_{c1}; those in Figure 3.12 by (GVA_{ct}/GVA_{indt}) and those in Figure 3.13 by GVA_{indt}. From Figure 3.13 it is evident that GVA_{indt} is decreasing over time (although one can observe some peaks in 1976, 1984, 1989 and 1994[33]). In Table 3.15 it

[33] The reason for the two peaks in 1984 and 1994 (as was explained in Section 3.2) is due to the changes into the VAT and IDBR registration, which resulted in a large number of small plants being discovered and, consequently, an increase in the size of the manufacturing industries (both in terms of number of plants and real GVA).

can be seen that GVA_{ct}/GVA_{c1} decreases over time; the denominator being constant, this means that GVA_{ct} is decreasing over time. The observed decrease in (GVA_{ct}/GVA_{indt}) in Figure 3.12 shows that over time the decrease in GVA_{ct} had been greater than the decrease in GVA_{indt}. For 1976, 1984, 1989 and 1994, the GVA_{indt} actually increased. Therefore, the reduction in (GVA_{ct}/GVA_{indt}) was even greater (see Figure 3.12).

These results are similar to those found by Dunne *et al.* (1989), in that they also found that the market share of the cohort of entrants, that entered the US manufacturing industries over the 1963-82 period, declined over time. This was due, mainly, to the exit of 61.5% of entrants within the first five years since entry and 79.6% within the first ten years. On the contrary, Baldwin (1995) found that in Canadian manufacturing industries, over the 1970-82 period, the share of new firms from the total manufacturing value added, increased over time. However, their share of the total number of firms decreased. This showed that the surviving firms grew significantly in size.

The findings of this section are as follows: 1) on average, the size (measured in real gross value added) of a new plant that opened between 1974-97 increased over time; 2) the reduction in the overall size of the cohorts of entrants (measured in real GVA), due to the closure of their plants, was greater than the increase in their overall size, due to increase in the real GVA of their plants; 3) the share of a given cohort of entrants, from the total manufacturing number of plants and their real GVA, declined over time; however, the decline in the share from the number of plants was greater than that from real GVA and 4) the cumulative share of entrants from the total manufacturing's real GVA increased, as time progressed. At the same time, the associated share for each individual cohort was decreasing. This decrease was even greater than the decline in the total manufacturing real GVA.

3.3.10 The cumulative (long-run) entry and exit rates

Cumulative entry rate is defined as the number of plants that opened between t-n and t (denoted here by En_t), divided by the total number of plants in year t (S_t). Similarly, the cumulative exit rate is defined as the number of plants that closed between t-n and n (Ex_t), divided by the total number of plants in t-n (S_{t-n}). In both definitions, 'n' refers to the number of lags in years. By choosing n=1, one can obtain the annual entry and exit rates (shown in Table 3.2). As n increases, the entry and exit rates can be obtained over a longer period. Panel A in Table 3.18 shows the long-run entry and exit rates (both in terms of number of plants and employment). The first five rows of Panel A are obtained by putting n=4 (except for the 1994-97 interval, where n=3). However, in order to measure entry and exit rates for a longer-run (over the 1974-97 interval), the last row of Panel A is calculated, when n=23. Panel B, in Table 3.18, shows the average annual entry and exit rates over the same intervals. These are obtained by calculating the average of the annual rates in Table 3.2.

Table 3.18 Long-run entry and exit rates, measured by number of plants and employment, using the weighted selected file, 1974-97 (figures are percentages)

	Entry rates		Exit rates	
	Number of plants	Employment	Number of plants	Employment
Panel A: Long-run rates				
1974-1978	21.6	5.5	24.9	8.8
1979-1983	16.9	5.7	26.4	13.7
1984-1988	35.0	12.2	27.7	12.2
1989-1993	28.2	10.3	34.5	17.1
1994-1997	46.8	32.0	48.2	33.2
1974-1997	89.7	62.6	85.4	63.2
Panel B: Average annual rates within each period				
1974-1978	6.5	1.6	6.6	1.7
1979-1983	3.4	1.2	7.5	2.6
1984-1988	21.8	4.8	7.2	2.9
1989-1993	14.5	3.8	3.5	3.5
1994-1997	23.2	11.6	12.8	12.8

If turnover process is marginal, entry happens only in the fringe of industries and entrants exit shortly after entry, then there will not be a large difference between the accumulated entry rates (the first two columns of Panel A) and the average short-run entry rates (the first two columns of Panel B), over a given interval. If one conceives the extreme case that entrants only survive for one year, then there will be no accumulated entry over time and the long-run entry rate (over the t-n, t interval) only includes entrants in period t. The longer lasting the entry, the greater will be the difference between the accumulated entry rate and the average annual rate, over a given interval. The same applies to exit; if exit is more confined to the fringes of an industry and not to the well established incumbents, then the accumulated exit rate, over a given interval (the last two columns in Panel A) will be very similar to the average short-run exit rate (the last two columns in Panel B). However, if exit also includes the well-established incumbents, then the accumulated exit rates, over a given interval, will be greater than the average annual exit rates, over that interval.

Comparing the entry rates in Panel A with Panel B, it is evident that the accumulated entry rates for the first two intervals are much higher than their corresponding average annual rates, although the difference is more pronounced in terms of the number of plants. On the other hand, from 1984 onwards, the difference between the accumulated entry rates and average annual entry rates appear to exhibit significant signs of decrease. Taking the 1974-78 period as an example, the accumulated entry rate over this interval is equal to 21.6%, when measured in terms of number of plants, and 5.5% in terms of employment. This means that out of the entire population of manufacturing plants in 1978, 21.6% of them entered after 1974 and their share of the total manufacturing employment in 1978 was 5.5%. This is compared with the average annual entry rates, over the same interval, which were only 6.5% when measured in terms of number of plants and 1.6% when measured in terms of employment. On the other hand, the accumulated entry rates over the 1994-97 period are 46.8% in terms of number of plants and 32% in terms of employment. These rates are compared with the average annual rates over the same interval, which were 23.2% in terms of number of plants and 11.6% in terms of employment. These findings shows that the number of entrants that could make it to the fourth year were much higher prior to 1984 than compared with the post-1984 years. Survival and therefore accumulation of entrants became more and more difficult as time proceeded, to the extent that over the 1994-97 interval, the accumulated entry rate was only 2 times higher than the average annual rate, when measured in terms of number of plants, and 2.7 times higher when measured in terms of employment.

Similarly, the proportion of manufacturing plants in 1974 that did not survive to 1978 was equal to 24.9% and their share of the total manufacturing employment was equal to 8.8%. These rates are compared with the average annual exit rates, over the same interval; that is 6.6% in terms of the number of plants and 1.7% in terms of employment. The difference between the long-run exit rates and the average annual exit rates is significant and remains significant over the next intervals. This implies that exit is not only confined to the fringe of manufacturing industries, but also includes incumbents. The last row of Panel A shows the accumulated entry and exit rate, over the 1974-97 interval, which is 89.7% and 85.4%, in terms of number of plants and 62.6% and 63.2%, in terms of employment, respectively.

At this point, it is beneficial to find out whether, as time proceeded, the increase in the accumulated entry and exit rates were due, mostly, to the entrants and exitors who gradually accumulated over time or as a result of the increase in the annual entry and exit rates. Thus, in Table 3.19 the annual entry rate, associated with the last year of a given interval, is deducted from the accumulated entry rate, over that interval. Similarly,

Table 3.19 **Difference between the long-run entry rate and the last year annual entry rate for a given interval (figures are in percentages)**

	Entry rates	
Difference between the long-run and short-run rates	Number of plants	Employment
1974-1978 versus 1977-78	16.4	4.5
1979-1983 versus 1982-83	13.9	4.5
1984-1988 versus 1987-88	20.4	8.4
1989-1993 versus 1992-93	15.5	7.2
1994-1997 versus 1996-97	32.2	20.1

Table 3.20 Difference between the long-run exit rate and the first year annual exit rate for a given interval (figures are in percentages)

	Exit rates	
Difference between the long-run and short-run rates	Number of plants	Employment
1974-1978 versus 1974-75	17.4	6.7
1979-1983 versus 1979-80	19.3	11.2
1984-1988 versus 1984-85	21.0	9.2
1989-1993 versus 1989-90	26.3	13.5
1994-1997 versus 1994-95	32.0	25.6

in Table 3.20, the annual exit rate associated with the first year of a given interval, is deducted from the accumulated exit rate, over that interval[34].

Table 3.19 shows the difference between the long-run and the short-run entry rates. A comparison between Table 3.19 and the first two columns of Panel A in Table 3.20, reveals that towards the end of the period, the increase in the long-run entry rates was, to a large extent, a result of the huge wave of entrants in the last year of the intervals. For example, over the 1989-93 period, out of 28.2% of plants in 1993 that did not exist in 1989, only 15.5% were accumulated entrants and 12.7% were entrants in 1993. However, over the 1974-78 interval, only 5.2% of entrants were entrants of the 1978 and the remaining 16.4% accumulated, over the interval.

[34] The reason for choosing the last year of an interval, in Table 3.19, and the first year in Table 3.20, is to make the subtractions meaningful. The denominator for the entry rate is the number of plants in year t, while the denominators for the exit rate is the number of plants in year t-n. Therefore, one has to subtract the annual entry rate in year t, from the long-run entry rate, over the t-n, t interval (in this case, both denominators will be equal to the number of plants in year t). Similarly, the annual exit rate in year t-n has to be subtracted from the accumulated exit rate, over the t-n, t interval (in this case, both denominators will be equal to the number of plants in year t-n).

The findings for exit rates are slightly less dramatic (The last two columns of Panel A in Table 3.18 are compared with Table 3.20). Over the 1974-1978 interval, out of the 24.9% of plants that existed in 1974, but did not survive to 1978, only 7.5% exited in 1975, while the remaining 17.4% gradually exited afterwards. However, over the 1994-97 interval, out of 48.2% of plants that existed in 1994 and did not survive to 1997, 32% were the result of accumulated exit and 16.2% was due to exit in 1995.

These findings are in line with the findings of Baldwin (1995), in that he also found that the accumulated entry and exit rates for Canadian manufacturing industries were greater than the average annual entry and exit rates, over 6 years intervals. However, in his study the annual entry and exit rates were much lower than for the present study and this resulted in a more gradual accumulation of entrants and exitors over time.

The findings of this section can be summarized as follows: 1) survival and accumulation of entrants over the five year intervals was much easier prior to 1984 as compared with the post-1984 period. In the 1990s, especially towards the end of the decade, the difference between the accumulated entry rates and the average short-run entry rates was much less compared to the earlier years, which meant that manufacturing industries were becoming more competitive and survival was becoming more difficult; 2) the accumulated exit rates appeared to be much higher than the average short-run exit rates and they remained high for all the intervals. This meant that incumbents as well as the entrants were among plants that exited over the chosen intervals; 3) In 1997, the accumulated entrants, over the 1974-97 interval, accounted for 89.7% of the plants and 62.6% of the employment. Similarly, the accumulated exit over this interval accounted for 85.4% of plants in 1974 and 63.2% of employment and 4) the long-run entry and exit rates were increasing over time, which was partly a result of the increase in the annual rates, especially, towards the 1990s period.

3.4 Summary and Conclusions

In this chapter, the magnitude of entry and exit in the manufacturing industries of the UK, over the 1974-97 period, were studied, together with various aspects of these processes. By studying the annual entry and exit rates at the total manufacturing level, it was found that both were increasing, over the period under study. More plants were taking their chance to enter the various markets but, at the same time, due to the presence of intense competition, more exits were also taking place. On average, the entry and exit rates were larger, when measured in terms of number of plants, than when measured in terms of employment. However, plants that opened relative to those that closed, were greater in terms of number, but smaller in terms of employment.

The entry and exit rates, measured at the four-digit manufacturing level, were not stable over time. This means that entry and exit rates were not affected by the structural characteristics of the individual industries, but rather the time-variant factors were more important. Given this, it was found that certain four-digit manufacturing industries were characterised with having consistently higher/lower than average *entry rates*, over the 1974-97 period, and certain industries with having consistently higher/lower than average *exit rates.* Similarly, certain years were characterised with having consistently higher/lower than average *entry rates*, across the four-digit manufacturing industries, and certain years with having consistently higher/lower than average *exit rates.* Over the 1974-97 period, the highest entry and exit rates were observed in the years of boom (the late 1970's), which could indicate that entry and exit may be pro-cyclical. Thus industry and time are important factors that need to be considered when modelling entry and exit.

Cohorts of entrants, during the 1974-97 period, were followed and it was found that the majority of entrants close shortly after entry. On average about half (43.7%) of the entrants exited by the fifth year. However, during the first 14 years after entry, no specific trend was found in the hazard rates of closure. This means that the risk of closure did not change during these years. However, hazard rates tended to increase afterwards. This increase could be due, partly, to high competition in the late 1990s and, also, the change to using IDBR registrations, which resulted in a higher hazard rates in these years.

By studying the contribution of the post-1973 and pre-1974 entrants to total closure, it was found that 10 years into the study time period (in 1983), the majority of closures taking place was due to the plants that opened prior to 1974.

Comparing the post-entry experience of the new plants with the incumbents, over the 1974-97 period, revealed that incumbents possessed a clear advantage over entrants, in any year following entry. This was evident by comparing their hazard rates in the years following entry.

On average, size (measured in real gross value added) of the entrants, during the 1974-97 period, increased. However, the overall size of the entry cohorts (measured in real gross value added) decreased, over time. This shows that the reduction in the size of the entry cohorts, due to the high closure of plants, was greater than the increase in the size of the cohorts, due to the increase in the size of their plants. Over time, the accumulated share of the post-1973 entrants, in terms of total manufacturing real GVA, was increasing. However, the size of the individual cohorts was decreasing and it was even greater than the decline in the total manufacturing's real GVA.

Finally, prior to 1984, the accumulated (long-run) entry rates, over the chosen intervals, were significantly higher than the average annual (short-run) rates. However, post-1984 the difference between the accumulated entry rates and the annual rates was not as high. This shows that survival was much easier for the entrants prior to 1984 while it became increasingly difficult from 1984 onwards. Similarly, the accumulated exit rates were much higher than the annual exit rates over the chosen intervals. This shows that exit did not only happen at the fringe of manufacturing industries, but with the incumbents. In 1997, 89.7% of plants, accounting for 62.6% of employment, were those that opened since 1974, while 85.4% of plants in 1974, accounting for 63.2% of employment, closed before 1997. However, the increase in the accumulated (long-run) entry and exit rates, over time, is due partly to the increase in the annual (short-run) rates, especially towards the end of the 1990s.

The raw data in this chapter contained various interesting and unexpected features. It showed that a large number of small plants were opening across various industries over the period under study. At the same time, exit was also occurring frequently. Overall, it seemed evident that entry and exit were taking place to a large extent, especially towards the late 1990's period. The finding that entry and exit may be pro-cyclical could suggest that over the periods of economic boom, more individuals were taking a chance to participate in various industries. However, the finding that almost half of the entrants exited before the fifth year reveals that survival was not as easy as entry. The initial small size of plants could perhaps be an important reason for the high failure rate of such plants, as the costs of adjustment to increase market penetration can be significantly high. What was even more striking was that exit was not evident only among the new entrants. Incumbents' life was also threatened by the intensity of the competition. A large displacement of existing plants also occurred over the 24 years under study; only 10.3% of plants in 1997 also existed in 1974, while the remaining 89.7% of plants were new entrants. This finding clearly shows the particular relevance of churning (i.e. "creative destruction" in Schumpeterian terms) in UK manufacturing industries and that it plays a significant role in restructuring these markets.

One might take the observed high level of dynamics as a sign of a healthy competition. However, one should not ignore the amount of costs that is involved in the opening of these plants. If these costs, such as costs on physical asset, costs of labour and the opportunity cost of such capital are added together and multiplied by the total number of entrants, then one can see how great are the social costs of entry. Given the evidence from the data on how frequent are entries and exits and how difficult is survival, one might think that maybe entry levels are too high and maybe barriers to entry are not high enough. If entry were more difficult then perhaps those that were capable of overcoming these barriers would be those who were more capable of surviving.

3.5 Appendix to Chapter 3

In estimating a model, determining y conditional on the exogenous variable x, if random sampling is applied (i.e. sampling is based on every one in the population having an equal, independent chance of getting into the sample) then there is no need for weighting, as in this case x is exogenous in the sample. However, when sampling is not random and it is based on the value of x, then it is necessary to weight the data, as in this case x is exogenous only in the population and not in the sample. In this case, if unweighted regression is used the estimated parameters will be inconsistent (Heckman, 1979; Hausman and Wise, 1981; Magee *et al.* 1998). Therefore, when there is the likelihood of endogenous sampling, weights have to be used if one wishes to have consistent parameter estimates. In the selected file, stratified sampling is based on the employment of establishments and this makes the employment variable endogenous in the sample. In this case, if unweighted regression is used, not only does it not represent the true relationship between y and x in the population, but also the estimated parameters will be inconsistent.

As a result of the above argument, population weights are applied, whenever the selected file is used. The weights were calculated at the 4-digit industry level, broken down into 5 size-bands and the status of the plant (in terms of whether it opened that year, closed the next year, or neither of these two categories). When they were less than five observations in each sub-group (industry × size-band × open/close status) then size-bands were amalgamated. If there were still insufficient observations, then status was dropped, and finally (if necessary) the industry definition was moved from a 4-digit to a 3-digit classification. Note that the 1980 Standard Industrial Classification was used throughout, with plants from 1970-79 reclassified from the 1968 SIC, while post 1994 data necessitated recoding from the 1992 SIC.

Chapter 4: The Determinants of Entry

4.1 Introduction

Entry of new competitors is considered an important phenomenon, which has various beneficial effects on markets. These include bringing down prices, reducing excess profits and x-inefficiency, introducing new products, and increasing process innovation. Markets that are subject to a large number of entrants are assumed to be flexible, efficient, and operating towards consumers' interests (Geroski, 1991b).

However, entry does not only relate to new firms setting up new plants (or new capacity), as classically defined by Bain (1956). According to Geroski (1991b), "entry by foreign-based producers through imports, entry by acquisition of an old-established firm or even entry by new managers effecting a thorough-going management shake-up in an existing firm all may have much of the same effect on the competitive process as entry more narrowly defined" (p. 10). Geroski (*ibid.*) further explained that new ideas have the same sort of impact on markets, in terms of creating the effects generally associated with entry by new firms.

Entry itself does not occur to the same extent in all industries and geographical locations; it depends on a combination of plant, industry, location and time specific factors. Most of the empirical work, regarding the factors that determine entry in U.K. manufacturing industries, either focus on entry into different industries, or across geographical regions. However, there has been a lack of empirical work that studies both industrial and geographical aspects at the same time. In this study, having access to the ARD[1], makes it possible not only to study, separately, the entry decisions of various types of entrants, but also to explore the various industrial and geographical factors that affect these decisions, simultaneously. In an attempt to do this, Section 4.2 considers

[1] Explained in Section 3.2.

various industrial and geographical specific factors that the literature predicts will affect entry[2]. Section 4.3.1 considers the magnitude of entry (plant opening) by different kinds of firms (domestic de-novo firms, domestic incumbents and foreign firms), in terms of the number of opened plants and their employment; it also compares their initial entry size. In Section 4.3.2, the plant entry rate (the dependent variable in subsequent analysis) is measured and its magnitude across various industries and geographical regions is examined. Section 4.3.3 discusses the various explanatory variables used to model entry, together with their definitions. Section 4.3.4 explains the econometric model employed in this study, and Section 4.3.5 considers the empirical results. Finally, Section 4.4 provides the conclusions for this chapter.

4.2 Literature review

4.2.1 Entry of different kinds of entrants

Entrants do not form a homogenous group. They have different attributes including: being owned by a foreign company, as opposed to a domestic company; or being owned by a new firm, as opposed to an already existing firm. These attributes might place some entrants in a position of relative superiority, compared to the others.

Caves (1971) made the distinction between foreign and domestic entrants. He stated that, due to the advantages that foreign entrants possess, it is easier for them to surmount structural entry barriers as identified by Bain (1956). Hines (1957) was among the first to point out that certain differences between entrants put some of them in an advantaging position, in terms of being able to overcome entry barriers. He distinguished between de-novo entry and entry by already established firms, and stated that the latter is a more common type of entry, as they are more capable of overcoming

[2] A comprehensive review of the literature, regarding various geographical and industrial specific factors that affect entry decisions, is provided in Chapter 2. Variables explained in Section 4.2 are those that will be included in the model. The reason for the exclusion of the other variables is unavailability of data.

entry barriers. According to Khemani and Shapiro (1988), failure to take account of the heterogeneity between entrants can result in a biased estimate of the height of any entry barrier. Geroski (1991a) divided entrants into two major categories i.e. domestic and foreign entrants. Khemani and Shapiro (1988) divided new plants into two categories: those that were owned by a new firm and those that were owned by an already existing firm. Other studies e.g. those by Gorecki (1975, 1976), Baldwin and Gorecki (1987) and Mata (1993) also made a distinction between the different kinds of entrants. Entrants have been categorised in some studies according to their entry size (Acs and Audretsch, 1989a; Acs and Audretsch, 1989b). However in this study entrants are not sub-divided by their entry size, as that would "stretch" the data too far[3].

The above studies all found significant differences between different kinds of entrants, in terms of their entry behaviour and their choice of industry. Therefore, making a distinction between different kinds of entrants appears to be necessary. Sections 4.2.2 and 4.2.3 provide a brief review of the factors that are expected to have a significant effect on the decision to open a new plant, with the review being based on the previous theoretical and empirical literature.

4.2.2 Industrial specific factors

4.2.2.1 Inducements to entry

Perceived profitability: present profits can be an indicator of post-entry profits. Therefore, the higher the level of profits in an industry, the higher is the likelihood of

[3] In this study, new plants are divided into three categories: new plants opened by domestic de-novo firms; those opened by domestic incumbents; and those opened by foreign firms. The dependent variable (plant opening rate) is then calculated, separately, for each kind of entrants, according to the year, two- digit manufacturing sector and the geographical region into which they entered. There are 20 two-digit manufacturing sectors, 11 geographical regions and 24 years, resulting in 5280 data points ($20\times11\times24$ is equal to 5280). However, not all kinds of entry are observed in all years and in all industries and geographical regions. Out of the 5280 cases, there are 1754 cases of 0 entry by domestic incumbents, 2202 cases of 0 entry by domestic de-novo firms and 3571 cases of 0 entry by foreign firms. If one was also to divide the entrants based on their entry size, this would increase the number of cases of 0 entry. Therefore, entrants are not going to be directly sub-divided, based on their entry size. However, size is accounted for in this study by calculating the dependent variable (plant opening rate) using the employment of the new plants rather than their actual numbers.

entry into that industry. However, in previous empirical work the effect of profits on entry has not been always significant[4]. Orr (1974), Harris (1976), Dunne and Roberts (1991) and Schwalbach (1991) found a positive impact of industry profits on entry. Dividing the entrants into foreign and domestic, Geroski (1991a) found that foreign entrants did not respond to increases in industry profit margins and that domestic entrants were quicker in their response to excess profits. Khemani and Shapiro (1988) found that both domestic and foreign entrants responded positively to profit opportunities. However, they found that within the category of domestic entrants, industry profits had a positive impact only on entry by de-novo firms and by established firms entering the same industry, while it had no significant impact on diversified entry. Khemani and Shapiro (1986) found that only de-novo entrants responded positively to an industry's profits; while Mata (1993) found that the only kind of entry that was encouraged by higher industry profits was expansion entry[5].

Industries' growth rate of demand: according to Siegfried and Evans (1994) entrants not only base their entry decisions on current or past profits, but also look at the trend in profits, as an indication of the future profitability of an industry. Therefore, they might take the growth rate in demand as an indicator of future profits. The following empirical studies have found that the industry growth rate in demand has had a positive impact on entry: Orr (1974), Hause and Du Rietz (1984), Khemani and Shapiro (1986), Highfield and Smiley (1987), Chappell *et al.* (1990), Schwalbach (1991) and Mayer and Chappell (1992). In fact, Mata (1993) found that growth in demand had an insignificant

[4] The first reason, according to Geroski (1995), is that variations in profits, across industries, are usually persistent over time and, therefore, have more of an industry specific nature rather than a time specific. On the other hand, entry variations are more transitory and time variant. Therefore, the correlation between entry and industry profits, with two different sources of variations, is not going to be significant. The second reason is that the relationship between entry and profits is not always straightforward, as more profitable industries are also more concentrated with stronger retaliatory reaction from the incumbents in case of entry (Cowling and Waterson, 1976; Clarke and Davis, 1982). This leaves a conflicting effect of industry profits on entry.

[5] This is explained in Footnote 3 to Chapter 2.

impact on entry of all different kinds of entrants. Baldwin and Gorecki (1987) found a positive impact of industry growth on domestic de-novo entry; in contrast, Geroski (1991a) found a negative impact. Khemani and Shapiro (1988) found that all different kinds of domestic entrants responded positively to industry growth, but not the foreign entrants. On the contrary, Gorecki (1975) found that foreign entrants were more responsive to industry growth, in comparison to domestic entrants.

Exit (the replacement effect): the causal relationship running from exit to entry can be due to two effects: a *replacement effect* and a *resource release*. Studying inter-industry differences in entry and exit, measured across the US manufacturing industries, Evans and Siegfried (1992) tested for the *replacement effect*. The reason proposed by them for the replacement effect was that previous exits leave room in the market for new entrants. Another explanation for this causal relationship, according to Brown *et al.* (1990), is that exit feeds back into entry by *releasing* resources for more efficient new entrants. Storey and Jones (1987) considered this possibility with respect to physical assets, in the sense that more second hand equipment will be available and at a cheaper price when exit is frequent. In the same vein, Love (1996) suggested that previous exits release entrepreneurial resources, which can increase self-employment.

Existence of fringe firms (small firms) in industry: movement of firms, in and out of industries, is usually by small firms. Therefore, the larger the population of small firms in an industry, the higher entry and exit are to be expected (Dunne *et al.* 1988). Rosenbaum and Lamort (1992) and Fotopoulos and Spence (1998) both found that the presence of small firms in an industry had a positive impact on the number of entries and exits taking place within.

4.2.2.2 Impediments to entry

Economies of large scale: Bain (1956) introduced economies of scale as a structural entry barrier. He explained, that if the minimum efficient scale (MES) in a market is large relative to its overall size, the necessity to produce at a cost efficient level could create a barrier for potential entrants. Various studies have found that MES had a negative impact of MES on entry (Harris, 1976; Hause and Du Rietz, 1984; Chappell *et al.* 1990; Mayer and Chappell, 1992). However, Highfield and Smiley (1987), Dunne and Roberts (1991) and Rosenbaum (1993) found that economies of scale had no significant impact on entry. Khemani and Shapiro (1988) and Mata (1993) both found that MES had a negative impact on entry by de-novo firms. Baldwin and Gorecki (1987) did not find any significant impact of MES on either group of domestic or foreign entrants. Mata (1993) found that MES had a positive impact on entry by purely diversifying entrants.

Absolute cost advantage of incumbent firms: Bain (1956) introduced this factor as a structural entry barrier. According to him, one of the reasons for having an absolute cost advantage by incumbents is peripheral access to the factors of production, especially capital. However, capital, *per se*, cannot create an absolute cost advantage for the incumbents, unless the expenditure is sunk. This means that it cannot be recovered in the case of an unsuccessful entry.

Orr (1974), Khemani and Shapiro (1986), Dunne and Roberts (1991) and Chappell *et al.* (1990) found that capital requirement had a negative impact on entry. Using data from 36 countries, Gschwandtner and Lambson (2002) found that industries with a higher level of sunk costs had significantly lower number of entrants. However, Highfield and Smiley (1987) did not find such an impact. Khemani and Shapiro (1986) and Mata (1993) found that only de-novo entrants responded negatively to the level of capital requirement. Dividing the entrants into foreign and domestic entrants, Gorecki (1975) found a negative impact of capital only on entry by domestic entrants.

Multi-plant operation: according to Duetsch (1984), existence of multi-plant firms in an industry can create a barrier for potential entrants[6]. Mayer and Chappell (1992) found that entry occurred less in industries dominated by a large population of multi-plant firms. Khemani and Shapiro (1986) found the same results only applied to de-novo entrants.

4.2.2.3 Inducements or impediments to entry

Concentration: Yip (1982) assigned two contrary effects to industry seller concentration: a barrier effect and an inducement effect. He explained that in highly concentrated industries, the threat of oligopolistic coordination by incumbents, in the face of entry, creates a barrier. However, if an entrant survives this barrier it can subsequently enjoy a less competitive environment in such industries. The following studies by Orr (1974), Chappell *et al.* (1990) and Mayer and Chappell (1992) found that concentration had a negative impact on entry. On the contrary, Duetsch (1975) and Harris (1976) found that concentration had a positive impact on entry. Looking at the entry of different groups of entrants, Gorecki (1975) found that concentration affected entry by domestic firms negatively, and Khemani and Shapiro (1988) also found it to have a negative impact, but only on entry by de-novo entrants.

[6] This is due to two effects: 1) if multi-plant configuration brings cost advantages to a firm, then the capital cost will be a more serious barrier for potential entrants, as, in this case, it has to be raised in order to set up a multi-plant firm and 2) having the advantage of operating in various product lines or segments of the markets, multi-plant firms can indulge easier in various activities (such as price competition) in order to deter entry.

4.2.2.4 The impact of industry life cycle

Gort and Klepper (1982), Hoff (1997) and Agarwal (1998) explored how markets evolve through various stages of their life cycle. They explained that the characteristics of the markets, in term of availability of information, nature of innovative activities and structural characteristic, changes as they go through various phases of their life cycle. In an infant industry, a large amount of external information is available, which motivates new entrants to participate in markets and exploit them. As a result, the number of entrants and output increases, which subsequently reduces prevailing prices. As markets evolve, incumbents' knowledge tends to replace external knowledge, which pushes the most inefficient firms out of the industry, causing net entry to reduce and concentration to increase over time. Klepper (1996) explained that, in mature industries, process innovation replaces product innovation and size brings an advantage for those firms involved in process innovation.

The above argument shows that as markets evolve, their structural characteristics also change which, according to Agarwal and Gort (1996), can affect the magnitude of entry into markets in two possible ways: 1) it changes the value of the explanatory variables on the right hand side of an entry equation 2) it alters the value of the parameter coefficients that relate entry to the explanatory variables. Therefore, in the current study, industries will be divided into "young" and "old" industries[7], based on the average age of their plants, noting that young industries in this study mainly are characterised as 'high technology' and 'capital intensive'.

[7] See Footnote 18 and the Appendix to this chapter.

4.2.3 Geographical specific factors

High demand in the local market: as particularly small firms usually serve local markets or restricted geographical areas, their success can be largely dependent on local demand (Storey, 1982). Fritsch (1992) and Armington and Acs (2002) both found that demand in the local market had a positive impact on new firm formation. However, Berglund and Brannas (2001) found that local demand had no significant impact on entry. In terms of the impact of demand in local market on foreign entry, Friedman *et al.* (1992) and Billington (1999) both found that the size of the host market had a positive impact on foreign direct investment decisions. However, Scaperlanda and Mauer's (1969) found no such significant impact.

Wealth of the individuals in the area: Reynolds *et al.* (1994) explained that start-up capital is the primary requirement to start a new business, which can be either provided by the entrepreneurs themselves or borrowed. In either case, the higher the wealth of residents in an area, the easier it is to provide such start-up capital. Cross (1981), Storey (1982) and Fotopoulos and Spence (1999) found that wealth, measured by the degree of house ownership, had a positive impact on new firm formation.

Existence of external economies of scale in the area: according to Armstrong and Taylor (2000), external economies of scale arise due to the geographic proximity of economic activities. Two sources contribute to the existence of external economies of scale: localization economies and agglomeration (or urbanization) economies[8].

[8] According to Armstrong and Taylor (2000) *localization economies* results from spatial concentration of related economic activities which, in the extreme case, could be due to the concentration of plants all belonging to the same industry. On the other hand, *agglomeration economies* are a result of geographical concentration of a large number of economic activities, which do not necessarily belong to the same industry (Henderson, 1986).

Specialization in an area occurs when the area is dominated by a particular industry and it contributes to the creation of localization economies. Garofoli (1994) and Fotopoulos and Spence (1999) found that area specialization had a positive impact on new firm formation. However, Gudgin (1978) contended that the higher the level of diversification, the higher is the number of new firms. The reason, proposed by him, was that a higher level of diversification indicates a higher variety of skills available locally.

Regarding the effect of agglomeration (or urbanization) economies on entry, Armstrong and Taylor (2000) explained that agglomerated areas create attractive locations for new business start-ups, due to the provision of a large number of facilities to service the industries. Armington and Acs (2002) measured agglomeration economies by industrial density and found that it had a positive impact on entry. On the contrary, Guimaraes *et al.* (1998) found in their sample that new firm formation was affected negatively by the population density of an area (a proxy for the degree of agglomeration economies). The reason suggested was that a high density in an area indicates a high level of congestion, which can offset the positive effects of agglomeration economies on new firm formation. Dumais *et al.* (1997) also found that new firms preferred less concentrated regions. In terms of the impact of density on foreign entry, Billington (1999) found that it had a negative impact on foreign direct investments in the UK.

Size structure of the area's factories: areas with large number of small firms tend to have higher rates of new firm formation. This is due to the fact that small firms are a better incubator for potential new firms than large firms (Cross, 1981). The reasons for this effect are as follows: 1) working in small firms provides the employers with the opportunity to familiarise themselves with a wide range of operational processes

(Storey, 1981); 2) in small firms, employers can have a closer contact with the managers of the company, which increases their confidence to start a new business (Mason, 1991); and 3) due to a lower job security is small companies, employees are encouraged to start their own business (Storey, 1982). The following studies found that areas with a large number of small plants had a higher formation of new businesses: Fritsch (1992), Garofoli (1994) and Fotopoulos and Spence (1999).

Unemployment: two conflicting hypothesis have been assigned to the effect of unemployment on new businesses formation. Unemployment in an area can either push individuals into starting their own businesses (Reynolds *et al.* 1994), or it can be an indicator of a lack of buoyancy in that area (Storey, 1982). Armington and Acs (2002) found that unemployment in an area positively affected the formation of new businesses. However, Fritsch (1992) and Garofolli (1994) found that unemployment had a negative effect on new business start-ups in an area.

Unemployment can have different implications for Foreign Direct Investment (FDI) decisions. It can imply the availability of a cheap workforce willing to work harder for a lower wage. Friedman *et al.* (1992) and Billington (1999) found that unemployment had a positive impact on FDI.

The North-South division: the so-called "north-south" divide in the UK is epitomised by the greater decline in manufacturing employment in the north. This caused inequality between the regions of the north and the south in terms of industrial development and social well-being (Townsend, 1983). Various studies have found major differences between the regions of the north and the south in a wide range of aspects including: regional growth, unemployment, rates of return on capital and firm formation (Keeble and Walker, 1994; Martin, 1997; Harris and Andrew, 2000). In the current study, the north includes the standard regions of the North, North West, Yorkshire and Humberside, West Midlands, Scotland, Wales and Northern Ireland, while the south includes the regions of the South East, South West, East Anglia and East Midlands.

4.3 Empirical work

4.3.1 Importance of different kinds of entrants

As it was explained in Section 3.3.1, entry in this study relates to setting up of a new plant (new capacity). However, as illustrated in Section 4.2.1, the owner firm can have different attributes; it can either be a foreign firm, as opposed to a domestic firm, or, be a de-novo firm, as opposed to an already existing firm. Therefore, in this study, entry (plant opening) is sub-divided into the following three categories:

1) Plant opening by a foreign firm (FOR).

2) Plant opening by a new domestic firm, i.e. de-novo entry (DE-NOVO).

3) Plant opening by a domestic incumbent (INCUM).

The second category includes all plants that are opened by new domestic firms, regardless of the firms being a single-plant or a multi-plant, while the third category includes plants being opened only by already existing domestic multi-plant firms[9].

Mata (1993) divided entry by incumbents into three different categories: expansion, extension and purely diversifying entry[10]. Khemani and Shapiro (1988) divided plant opening by incumbents into two categories: new plants built in the same industry and new plants built in a different industry. In this study it is not possible to divide plant

[9] Plant opening by the last category includes all plants that are opened, regardless of the industry into which they entered.

[10] If entry was in the same five-digit sector it was an extension entry. If it was into a different five-digit, but the same three-digit sector it was an expansion entry. Finally, if it was into a different three-digit sector, it was a purely diversifying entry

opening by incumbents into further sub-categories. The reason is that the dependent variable[11] (i.e. entry rate) is calculated, separately, for each kind of entry (i.e. FOR, DE-NOVO and INCUM) at both the industry and regional level. Dividing the entrants into further sub-categories will result in having too many zeros (i.e. no entry occurring) for the dependent variable[12].

Using the weighted selected file in the ARD[13], the share of each group of entrants (based on the number of plants and their employment) has been calculated and is shown in Table 4.1. In terms of the three categories used, plant opening by domestic incumbents has the largest share of entry (in terms of both total number of opened plants and their employment, except for 1993) and foreign entry has the smallest share. On average, over the 1974-97 period, plant opening by foreign firms accounted for 10.6% of plants and 12.6% of the employment; plant opening by new domestic firms for 29.9% and 31%, respectively, and plant opening by domestic incumbents for 59.5% and 56.3%, respectively. Therefore, the majority of entries (both in terms of the number of plants and their employment) were by domestic incumbents building new plants.

It is also useful to consider the average initial size of entrants in each group. The median size of entrants in each category is shown in Table 4.2. The first column, in Table 4.2, shows the median size of new plants, opened by foreign firms. The second category of entrants comprises both new domestic single-plant and multi-plant firms. Therefore, the median size for each sub-group is presented in columns 2.1 and 2.2. Finally, column 3 shows the median entry size by domestic incumbents. A comparison between the columns in Table 4.2 reveals that new plants opened by new domestic single-plant firms (column 2.1) on average had the largest initial size in comparison to the other entrants.

[11] Dependent variable is explained in Section 4.3.2.
[12] See Footnote 1.
[13] This is fully explained in Section 3.2.

Table 4.1 Share of different kinds of entrants, measured in terms of number of plants and employment (% of all plants opened in year)

	New plants opened by foreign firms (1)		New plants opened by domestic de-novo firms (2)		New plants opened by domestic incumbents (3)	
Year	Number	Employment	Number	Employment	Number	Employment
1974	6.3	7.0	33.4	34.0	60.3	59.1
1975	5.0	6.8	33.7	29.3	61.3	63.9
1976	6.6	6.6	36.2	38.4	57.2	55.0
1977	7.3	9.8	30.6	28.4	62.0	61.7
1978	8.0	8.5	22.9	23.2	69.1	68.3
1979	7.6	11.3	22.1	23.6	70.3	65.0
1980	18.0	14.8	19.5	18.6	62.5	66.6
1981	11.1	18.4	19.0	22.7	69.9	58.9
1982	13.2	12.3	26.3	26.7	60.5	61.1
1983	13.8	11.2	18.7	20.2	67.5	68.5
1984	3.8	5.4	26.6	41.5	69.5	53.1
1985	10.3	10.2	28.1	35.1	61.6	54.6
1986	8.9	9.2	37.2	38.0	53.9	52.9
1987	11.1	13.9	31.4	30.7	57.4	55.4
1988	10.2	15.2	37.3	35.7	52.4	49.1
1989	8.1	10.3	42.4	42.6	49.4	47.2
1990	14.3	17.5	31.8	31.9	53.9	50.6
1991	14.9	22.0	32.1	28.6	53.0	49.4
1992	14.0	14.3	28.7	34.9	57.3	50.8
1993	8.4	13.0	52.5	46.1	39.1	40.8
1994	11.6	11.2	25.6	29.6	62.8	59.1
1995	12.2	15.7	43.5	40.1	44.3	44.2
1996	16.1	20.7	24.9	30.2	59.0	49.1
1997	14.0	17.3	12.9	14.7	73.0	68.0
Average	10.6	12.6	29.9	31.0	59.5	56.3

Source: The ARD is explained in Section 3.2.
Each cell is calculated as entry rate into that specific sub-category, divided by total entry rate.

Table 4.2 Median initial size of the opened plants, by different kind of entrants

Year	New plants opened by foreign firms (1)	New plants opened by new domestic firms (2)		New plants opened by domestic incumbents (3)
		New plants opened by new domestic single-plant firms (2.1)	New plants opened by new domestic multi-plant firms (2.2)	
1974	12	19	11	11
1975	19	20	14	17
1976	19	23	15	17
1977	26	18	13	18
1978	6	17	6	5
1979	6	18	11	6
1980	8	27	10	10
1981	11	26	10	9
1982	11	29	10	10
1983	10	27	9	11
1984	7	18	9	7
1985	8	18	10	8
1986	7	25	7	9
1987	10	24	7	8
1988	9	12	7	7
1989	8	10	8	7
1990	8	14	7	7
1991	9	15	7	8
1992	8	12	7	6
1993	8	12	9	7
1994	6	16	6	6
1995	7	16	8	6
1996	9	15.5	10	6
1997	8	13	11	6
Average	10	18.5	9.2	8.8

Hence, it can be concluded that in the U.K. manufacturing industries over the 1974-97 period, the most frequent type of entry (measured both in terms of number of plants and their employment) was entry by domestic incumbents seeking new markets, either in the same or in a different industry, followed by entry by new domestic firms and, finally, entry by foreign firms. On the other hand, plants opened by new domestic firms had the largest initial size out of the three categories of entrants, which was mainly the result of the large initial size of new plants opened by new domestic single-plant firms.

4.3.2 Measuring entry (plant opening) rates

In this section, entry (plant opening) rate variations, across two-digit manufacturing sectors and the geographical regions of the U.K, are examined. In order to measure entry rates, the data provided in the ARD[14] will be used. Using the 1980 Standard Industrial Classification (SIC80) indicator, it is possible to identify the two-digit manufacturing sector to which plants belong. At the same time, the regional geographical indicator, provided in the ARD, enables one to find the geographical region in which plants are located. There are 20 two-digit manufacturing sectors in the U.K. and 11 geographical regions (including Wales, Scotland and Northern Ireland). Since the entry rate will be measured for a particular two-digit manufacturing sector in a specific region in a given year, the outcome is 220 (20×11) different cross sections, followed over 24 years (i.e. 1974-97). Moreover, as entrants (new plants) are divided into three different sub-categories (plants opened by foreign firms, plants opened by new domestic firms and plants opened by domestic incumbents), entry relates to plant opening by a given sub-category of entrants in a given year, into a specific two-digit manufacturing sector and in a specific region.

[14] ARD has been explained in Section 3.2.

Table 4.3 shows the average share of each two-digit manufacturing sector, from total manufacturing employment, over the 1974-97 period. Similarly, Table 4.4 shows the average share of each region from total manufacturing employment, over the 1974-97 period. Table 4.3 shows that the food, drink and tobacco manufacture industries (with 12.5% average share from total manufacturing employment[15]) on average had the largest share from total manufacturing employment, over the 1974-97 period, and the extraction of minerals (with 0.2%) had the smallest share. On average over the period under study, the five largest industries (Food, drink and tobacco, Mechanical engineering, Electrical and electronic engineering, Manufacture of paper and paper products and Manufacture of other transport equipment) stand for almost half of manufacturing employment (49.7%).

U.K. manufacturing employment, over the 1974-97 period, was also unevenly distributed across its geographical regions (see Table 4.4). The South East region, on average, had the highest proportion of the manufacturing employment (22.8%), while Northern Ireland possessed the smallest share (2.5%). On average, over the 1974-97 period, almost half of the manufacturing employment (49%) was concentrated in just three regions of the UK (South East, West Midlands and North West).

Looking at the geographical distribution of the individual industries, significant differences are again observed (see Table 4.5). For instance, although the food, drink and tobacco manufacture industries had the highest share of total manufacturing employment, it accounted for only some 2.4% of manufacturing employment in the South East region. However, the electrical and electronic engineering industries were more important in the South East region, having a share of 3.9% of total manufacturing employment. In comparison, industries such as the chemical industry and the production

[15] Figures in Table 4.3 are calculated by obtaining the average of the shares of each two-digit manufacturing sector from total manufacturing employment, over the 1974-97 period.

Table 4.3 Average share of the two-digit manufacturing sectors of the UK from total manufacturing employment, over 1974-97

Two-digit manufacturing sectors	The two-digit SIC80 indicator	Average share from total manufacturing employment (%)	Rank
Food, drink and tobacco manufacture Industries	41	12.48	1
Mechanical engineering	32	11.71	2
Electrical and electronic engineering	34	11.15	3
Manufacture of paper and paper products; printing and publishing	47	7.64	4
Manufacture of other transport equipment	36	6.79	5
Chemical industry	25	6.68	6
Manufacture of metal goods not elsewhere Specified	31	6.20	7
Footwear and clothing industries	45	5.99	8
Textile industry	43	5.74	9
Manufacture of motor vehicles and parts	35	5.54	10
Manufacture of non-metallic mineral products	24	4.22	11
Processing of rubber and plastics	48	4.14	12
Metal Manufacturing	22	4.05	13
Timber and wooden furniture industries	46	2.99	14
Instrument engineering	37	1.46	15
Other manufacturing industries	49	1.33	16
Manufacture of office machinery and data processing equipment	33	0.95	17
Production of man-made fibres	26	0.38	18
Manufacture of leather and leather goods	44	0.37	19
Extraction of minerals not elsewhere specified	23	0.18	20

Table 4.4 Average share of the standard regions of the UK from total manufacturing employment, over 1974-97

Standard regions	Average share from total manufacturing employment (%)	Rank
South East	22.8	1
West Midlands	13.2	2
North West	13.0	3
Yorkshire and Humberside	10.1	4
East Midlands	9.7	5
Scotland	8.3	6
South West	6.8	7
Northern	5.7	8
Wales	4.5	9
East Anglia	3.3	10
Northern Ireland	2.5	11

Table 4.5 Average employment share of different industries and regions from total manufacturing employment, over the 1974-97 period (%)

	Geographical Regions											
Two-digit Manufacturing industries	South East	East Anglia	South West	West Midlands	East Midlands	Yorkshire and Humberside	North West	North	Wales	Scotland	Northern Ireland	Standard Deviation
Metal manufacturing	0.30	0.02	0.06	0.81	0.25	0.91	0.20	0.41	0.79	0.29	0.01	0.003
Extraction of minerals not elsewhere specified	0.04	0.01	0.03	0.01	0.02	0.00	0.03	0.02	0.01	0.01	0.01	0.000
Manufacture of non-metallic mineral products	0.6	0.10	0.26	1.25	0.37	0.45	0.42	0.19	0.17	0.27	0.10	0.003
Chemical industry	1.95	0.17	0.26	0.28	0.45	0.62	1.49	0.64	0.28	0.48	0.06	0.006
Production of man-made fibres	0.00	0.00	0.04	0.02	0.06	0.08	0.03	0.08	0.03	0.01	0.06	0.000
Manufacture of metal goods not elsewhere specified	1.02	0.11	0.27	2.13	0.57	0.72	0.55	0.19	0.26	0.34	0.05	0.006
Mechanical engineering	2.65	0.49	0.78	1.59	1.19	1.35	1.42	0.80	0.30	1.00	0.15	0.007
Manufacture of office machinery and data processing equipment	0.39	0.02	0.03	0.11	0.02	0.03	0.11	0.01	0.04	0.19	0.01	0.001
Electrical and electronic engineering	3.87	0.41	0.72	1.58	0.64	0.42	1.18	0.63	0.69	0.81	0.18	0.010
Manufacture of motor vehicles and parts	1.59	0.11	0.18	1.81	0.20	0.29	0.74	0.16	0.26	0.15	0.05	0.006
Manufacture of other transport equipment	1.35	0.06	1.18	0.39	0.94	0.42	0.98	0.49	0.14	0.58	0.26	0.004
Instrument engineering	0.60	0.06	0.17	0.09	0.07	0.07	0.11	0.04	0.07	0.16	0.02	0.002
Food, drink and tobacco manufacture industries	2.38	0.91	0.98	1.03	1.08	1.58	1.59	0.57	0.40	1.48	0.47	0.006
Textile industry	0.14	0.02	0.12	0.26	1.52	1.16	1.12	0.18	0.08	0.80	0.34	0.005
Manufacture of leather and leather goods	0.07	0.01	0.04	0.05	0.05	0.04	0.05	0.01	0.01	0.03	0.01	0.000
Footwear and clothing industries	0.73	0.14	0.40	0.32	1.05	0.66	1.02	0.47	0.29	0.50	0.43	0.003
Timber and wooden furniture industries	0.83	0.14	0.24	0.23	0.23	0.36	0.31	0.16	0.15	0.23	0.09	0.002
Manufacture of paper and paper products; printing and publishing	2.86	0.31	0.57	0.45	0.51	0.56	0.99	0.33	0.26	0.67	0.13	0.008
Processing of rubber and plastics	0.91	0.20	0.36	0.62	0.37	0.28	0.58	0.27	0.22	0.24	0.09	0.002
Other manufacturing industries	0.48	0.06	0.09	0.15	0.09	0.10	0.11	0.05	0.10	0.10	0.01	0.001
Standard Deviation	0.011	0.002	0.003	0.007	0.004	0.005	0.005	0.002	0.002	0.004	0.001	

of man-made fibres, approximately, had equal shares of manufacturing employment in Northern Ireland, while in the UK as a whole the former industry had a relatively high proportion of manufacturing employment relative to man-made fibres. On average, the South East region had the most uneven distribution in the share of its different sectors from total manufacturing employment (i.e. it was more diversified), as is evident from its standard deviation (0.011), while Northern Ireland had the most even distribution (the standard error of the share of its sectors from total manufacturing employment is equal to 0.001).

The observed marked differences in the distribution of manufacturing employment, across different two-digit manufacturing sectors and geographical regions, means that these need to be controlled for, when looking at plant entry across different two-digit manufacturing sectors and geographical regions.

In the regional economic literature, two approaches have mainly been used, when comparing plant birth rates across geographical regions (Fritsch, 1992; Armington and Acs, 2002). The first approach, called the ecological approach, standardises the number of entrants in a region, with respect to the number of establishments already in existence. However, regions vary in their average number of employees per establishment so this approach can result in a higher birth rate in regions with higher than average establishment size (as the denominator becomes smaller) and a lower birth rate in regions with lower than average establishment size. Therefore, it is necessary to control for plants' sizes, in order to overcome this measurement bias that is inherent in the ecological approach.

The second approach, called the labour market approach, standardises the number of new entrants with respect to the size of the labour force in the region. This method has a specific theoretical appeal in that it is based on the entrepreneurial choice model proposed by Evans and Jovanovic (1989), who assumed that each new business is started by a new entrepreneur. This assumption means that entrepreneurs come from the same market in which a new business operates. In the extreme case, where each entrepreneur has started his/her own business, the plant opening rate (defined as number of plants opened in a region, divided by the size of the labour force in that region) takes a value of one.

In the current study, as in the labour market approach, employment size is chosen as the denominator for the plant opening rate. However, in the numerator, instead of the number of new plants, their employment is chosen. The reason for this is that the effect of entry on competition is associated, directly, with the size of entrant, in terms of their employment or their output, which subsequently affects market prices. Therefore, the entry (plant opening) rate is defined as employment due to new plant opening by a given group of firms (foreign firms, new domestic firms and domestic incumbents) in the industry i, region j and year t, divided by total employment in that industry, region and year.

Average entry rates, over the 1974-97 period are calculated for each group of entrants separately, and are presented in Tables 4.6, 4.7 and 4.8. Each cell in these tables is calculated as

$$\frac{\sum_{t=1}^{24} \frac{e_{ijt}^{k}}{E_{ijt}}}{24} \qquad (i=1,2\ldots20; j=1,2\ldots11; t=1,2\ldots24; k=1,2,3)$$

where, e_{ijt}^{k} denotes employment due to entry by a specific group of entrants, k, into the two-digit manufacturing sector, i, in the geographical region, j, in year t and E_{ijt} represents total employment of the manufacturing sector, i, in region, j, and year t.

From Table 4.6, it is evident that over the 1974-97 period the manufacturing of office machinery and data processing equipments had on average the highest entry rate by

Table 4.6 Average plant opening rate by foreign firms, over 1974-97, across two-digit manufacturing sectors and standard geographical regions of the UK

	Geographical Regions											
Two-digit Manufacturing industries	South East	East Anglia	South West	West Midlands	East Midlands	Yorkshire and Humberside	North West	North	Wales	Scotland	Northern Ireland	Average
Metal manufacturing	0.66	0.37	1.81	0.49	0.23	0.29	0.63	0.17	0.08	0.18	0.00	0.45
Extraction of minerals not elsewhere specified	0.00	0.00	0.00	0.00	2.75	0.00	0.00	0.26	0.58	0.00	0.00	0.33
Manufacture of non-metallic Mineral products	0.80	0.38	0.56	0.40	0.12	0.48	0.67	0.96	1.28	0.78	0.77	0.65
Chemical industry	1.90	1.38	0.80	0.83	0.98	0.66	0.76	0.30	0.84	1.21	0.73	0.94
Production of man-made fibres	6.25	4.43	0.00	0.77	0.45	0.00	2.17	0.00	4.35	0.00	1.76	1.83
Manufacture of metal goods not elsewhere specified	0.59	0.70	0.43	0.17	0.33	0.45	0.39	0.52	0.60	1.07	0.72	0.54
Mechanical engineering	0.91	0.82	1.17	0.68	0.91	0.31	0.46	0.47	0.85	1.27	0.36	0.75
Manufacture of office machinery and data processing equipment	4.66	10.68	4.59	2.56	0.54	4.47	2.52	17.64	1.44	1.57	6.52	5.20
Electrical and electronic engineering	1.01	0.68	1.05	0.73	0.19	0.66	0.63	0.71	0.83	1.36	0.76	0.78
Manufacture of motor vehicles and parts	1.31	0.13	0.35	0.44	0.25	0.60	0.32	1.01	0.41	0.29	0.11	0.48
Manufacture of other transport equipment	0.63	0.34	0.18	0.88	0.32	1.36	0.20	0.08	0.51	0.66	1.23	0.58
Instrument engineering	1.12	0.02	0.28	1.09	1.26	0.31	0.54	0.46	0.96	0.62	4.95	1.06
Food, drink and tobacco manufacture industries	0.74	0.21	0.31	0.31	0.32	0.18	0.42	0.39	0.45	0.37	0.30	0.37
Textile industry	0.45	0.00	0.57	0.04	0.16	0.17	0.18	1.05	0.03	0.16	0.05	0.26
Manufacture of leather and leather goods	0.00	0.00	0.00	0.00	0.21	0.00	0.01	0.00	0.00	0.00	0.00	0.02
Footwear and clothing industries	0.28	0.00	0.10	0.07	0.10	0.13	0.03	0.03	0.06	0.22	0.02	0.10
Timber and wooden furniture	0.24	0.05	0.47	0.13	0.24	0.86	0.25	0.07	0.34	0.11	0.03	0.25
industries	0.67	0.43	0.35	0.60	0.76	0.70	0.63	0.54	0.89	0.45	0.37	0.58
Manufacture of paper and paper												
products; printing and publishing	0.58	0.67	0.44	0.68	1.62	0.29	0.30	0.49	1.09	0.47	0.76	0.67
Processing of rubber and plastics	0.78	0.05	0.00	0.12	0.17	0.11	0.28	0.21	0.01	0.01	0.00	0.16
Other manufacturing industries												
Average	1.18	1.07	0.67	0.55	0.60	0.60	0.57	1.27	0.78	0.54	0.97	0.80

Table 4.7 Average plant opening rate by new domestic firms, over 1974-97, across two-digit manufacturing sectors and standard geographical regions of the UK

	Geographical Regions											
Two-digit Manufacturing industries	South East	East Anglia	South West	West Midlands	East Midlands	Yorkshire and Humberside	North West	North	Wales	Scotland	Northern Ireland	Average
Metal manufacturing	1.04	4.35	0.65	1.02	0.73	0.69	0.91	0.10	0.47	1.72	0.95	1.14
Extraction of minerals not elsewhere specified	1.56	1.38	9.75	4.28	0.53	0.00	3.95	0.31	3.32	1.55	1.80	2.58
Manufacture of non-metallic mineral products	1.38	1.70	1.57	1.07	1.49	0.65	0.59	1.15	1.39	1.26	2.28	1.32
Chemical industry	0.87	0.69	1.02	1.15	0.99	0.88	0.84	0.54	1.01	0.82	1.63	0.95
Production of man-made fibres	6.25	10.00	0.68	0.00	0.17	0.07	1.61	0.95	0.00	6.71	0.36	2.44
Manufacture of metal goods not elsewhere specified	2.22	2.89	2.41	1.37	1.45	1.90	2.50	2.77	2.12	1.78	3.96	2.31
Mechanical engineering	1.99	1.37	2.25	1.79	1.47	1.79	1.76	1.40	2.59	1.79	4.54	2.07
Manufacture of office machinery and data processing equipment	3.68	5.94	2.75	4.76	3.63	4.05	1.91	1.33	2.19	1.05	4.25	3.23
Electrical and electronic engineering	1.44	1.42	1.65	1.17	1.04	2.32	1.35	1.56	1.57	1.49	2.28	1.57
Manufacture of motor vehicles and parts	0.70	0.96	1.17	0.49	1.42	1.09	0.86	0.74	0.55	2.66	6.01	1.51
Manufacture of other transport equipment	1.14	1.92	0.33	0.91	0.42	0.87	0.14	0.35	0.71	1.14	0.04	0.72
Instrument engineering	1.55	1.64	1.21	2.00	2.72	1.63	2.36	2.28	2.73	1.25	0.99	1.85
Food, drink and tobacco manufacture industries	1.23	1.02	1.68	1.28	0.94	1.03	1.70	1.25	1.86	1.54	2.34	1.44
Textile industry	2.62	0.87	0.51	1.09	0.86	0.74	1.42	0.95	3.91	0.66	0.88	1.32
Manufacture of leather and leather goods	1.18	3.37	1.66	4.78	0.81	0.69	2.21	3.09	1.21	0.32	3.07	2.04
Footwear and clothing industries	3.01	1.37	0.47	2.63	1.88	1.01	1.42	1.26	2.20	1.40	1.55	1.66
Timber and wooden furniture industries	2.81	3.36	1.89	4.10	3.59	2.55	3.42	2.37	2.02	2.35	4.19	2.97
	1.88	1.55	1.74	1.76	2.01	1.11	1.16	0.89	1.45	1.09	2.30	1.54
Manufacture of paper and paper products; printing and publishing	2.53	1.24	1.07	1.74	2.30	2.21	1.95	1.04	2.47	2.21	2.53	1.94
Processing of rubber and plastics	1.72	3.32	3.59	3.32	2.53	3.45	3.13	0.39	1.56	3.45	5.40	2.90
Other manufacturing industries												
Average	2.04	2.52	1.90	2.04	1.55	1.44	1.76	1.24	1.77	1.81	2.56	1.87

Table 4.8 Average plant opening rate by domestic incumbents, over 1974-97, across two-digit manufacturing sectors and standard geographical regions of the UK

	Geographical Regions											
Two-digit Manufacturing industries	South East	East Anglia	South West	West Midlands	East Midlands	Yorkshire and Humberside	North West	North	Wales	Scotland	Northern Ireland	Average
Metal manufacturing	1.92	1.18	2.46	2.76	1.68	1.29	1.71	2.71	1.38	2.34	0.83	1.84
Extraction of minerals not elsewhere specified	5.04	2.10	7.31	7.28	4.03	11.06	4.54	6.14	1.88	9.45	0.23	5.37
Manufacture of non-metallic mineral products	5.32	5.32	6.10	2.07	4.70	2.99	3.73	4.77	4.27	4.29	4.04	4.33
Chemical industry	2.71	2.97	2.71	3.84	3.14	2.86	2.07	2.15	1.85	1.94	2.25	2.59
Production of man-made fibres	0.00	0.00	0.42	6.03	2.66	0.53	4.35	2.26	0.00	9.09	0.41	2.34
Manufacture of metal goods not elsewhere specified	1.89	1.82	2.32	2.20	1.51	2.56	2.46	2.08	2.30	2.83	1.20	2.11
Mechanical engineering	2.34	1.61	1.93	2.94	1.73	2.18	2.42	2.35	2.84	2.59	1.31	2.20
Manufacture of office machinery and data processing equipment	2.84	1.20	4.25	2.46	2.59	4.13	3.97	3.22	10.98	1.16	1.13	3.45
Electrical and electronic engineering	2.44	1.20	2.65	1.43	2.57	3.29	1.70	1.22	1.61	1.77	1.40	1.93
Manufacture of motor vehicles and parts	0.71	1.27	2.72	1.12	2.92	1.22	1.12	0.90	1.07	3.22	1.09	1.58
Manufacture of other transport equipment	1.82	3.21	2.08	1.37	0.64	0.75	1.06	0.27	0.90	0.67	0.12	1.17
Instrument engineering	2.75	2.18	2.20	2.48	1.76	1.88	2.98	1.71	3.03	1.19	0.21	2.03
Food, drink and tobacco manufacture industries	3.32	1.92	2.70	2.05	2.70	2.53	1.98	2.42	2.66	2.31	1.53	2.37
Textile industry	3.80	4.08	1.92	3.92	2.18	1.62	2.17	1.41	0.96	1.85	1.82	2.34
Manufacture of leather and leather goods	1.91	1.61	4.05	2.69	1.42	1.18	2.11	4.69	4.55	2.73	0.00	2.45
Footwear and clothing industries	2.86	2.78	2.31	3.08	2.58	3.57	2.78	2.94	4.04	1.99	1.59	2.78
Timber and wooden furniture industries	3.79	1.66	3.92	4.32	2.29	2.49	4.05	4.39	7.08	4.44	1.00	3.58
	3.22	2.23	3.43	3.11	2.69	2.34	1.71	3.32	2.62	2.40	3.25	2.76
Manufacture of paper and paper products; printing and publishing	3.28	2.67	3.62	2.54	3.32	3.28	2.71	2.25	4.65	2.15	1.08	2.87
Processing of rubber and plastics	2.21	2.34	2.20	1.50	2.05	2.55	1.96	0.78	0.47	1.18	0.00	1.57
Other manufacturing industries												
Average	2.71	2.17	3.07	2.96	2.46	2.72	2.58	2.60	2.96	2.98	1.22	2.58

foreign firms (5.2%), the production of man-made fibres had the second highest (1.8%) and instrument engineering had the third highest (1.1%). However, the distribution of new foreign owned plants varied significantly across geographical regions. For example, foreign entry into office machinery and data processing equipment was concentrated mainly in the regions of the North, East Anglia and Northern Ireland, while entry into the production of man-made fibres industry was concentrated mainly in the South East, East Anglia and Wales. Although the Northern region had the second highest foreign entry rate (1.3%), this was due mainly to their entry into the manufacture of office machinery and data processing equipment (17.6%). On average, the South East region had the highest entry rate by foreign enterprises (1.2%) and Scotland the lowest (0.5%).

Examining entry by new domestic firms (see Table 4.7), the highest entry rates were in the production of man-made fibres sector in East Anglia (10%), the extraction of minerals in the South West (9.7%) and the production of man-made fibres in Scotland (6.7%). Examining the distribution of new plants opened by new domestic firms across geographical regions, the production of man-made fibres had the most uneven distribution of entry rates (with a 10% entry rate in East Anglia and 0% in West Midlands), while the manufacturing of office machinery had the least uneven distribution of entry rates (it varied between 5.9% in East Anglia and 1.1% in Scotland). On average, the manufacture of office machinery and data processing equipment had the highest entry rate by new domestic firms across the geographical regions (3.2%) and the manufacture of other transport equipment had the lowest (0.7%).

Finally, Table 4.8 shows the average entry rate by domestic incumbents, over the 1974-97 period. On average over this period the highest entry rates, by domestic incumbents, were observed in the extraction of minerals in Yorkshire and Humberside

(11.1%), the manufacture of office machinery in Wales (11%) and the extraction of minerals in Scotland (9.4%). Over the period under study, the extraction of minerals had on average the highest entry rate by domestic incumbents across the regions (5.4%) and the manufacture of other transport equipment had the lowest (1.2%).

This section shows that the regional and industrial concentration of U.K. manufacturing employment over the 1974-97 period was unevenly distributed, which thus shows the necessity to control for these differences when measuring entry in the geographical regions and industrial sectors. However, after controlling for the different sizes of manufacturing sectors and regions, there still remains a marked difference in entry rates across different manufacturing sectors and geographical regions. This section shows that though a given industry in a certain regions might face a high entry rate, by a particular group of entrants, it might not be an attractive option for that group in another region. In the same way, a given region might have a high entry rate into one industry but not into another, due to differences in the characteristics of those industries. Therefore, the decision to open a new plant is determined by both the characteristics of the industries and the regions.

4.3.3 Independent variables

Chapter 2 provided a comprehensive review of the variables listed in the literature that are deemed to be important determinants of the entry decision. However, due to unavailability of data, it is not possible to accommodate all of them in the model used in this study. The industrial specific factors are calculated using the data provided in the ARD[16]. However, the ARD provides information on advertising expenditure only for the 1984-92 period, while it provides no information on R&D expenditure. At the same

[16] See Section 3.2.

time, there is no available information regarding binding commitments and strategic limit pricing. In terms of the geographical specific variables, the associated data was collected from 'Regional Trends' (Regional Trends, various issues). All geographical specific factors, as explained in Chapter 2, are included in the model except for the occupational structure of the residents in an area, for which data goes back only to 1982. As this study covers the 1974-97 period, it was decided not to include those variables for which data does not exist for the entire time period. The final list of the variables included in the analysis together with their definitions is shown in Table 4.9.

Starting with the industry specific variables, $PROFIT_{it}$ measures the profit margin in industry i and year t and is used as a proxy for the future profitability of an industry. This variable is expected to affect entry in a positive way. However, this measure does not entirely capture the future profitability of an industry, as entrants are unlikely to have the naïve expectation that their entry will not affect the market equilibrium (Mata, 1993). In order to capture this effect, one must also take account of the industry growth rate of demand, for which the growth rate of output is used as a proxy. $GROWTH_{it}$ is expected to encourage entry (Schwalbach, 1991).

EX_RATE_{it} measures the room left in the market, due to exit in the previous period. It captures the replacement effect and is expected to have a positive impact on entry (Evans and Siegfried, 1992). In order to measure the magnitude of the fringe of an industry, the variable $SMALL\_FIRM_{it}$ is calculated. The expectation is that a large fringe will affect entry in a positive way (Fotopoulos and Spence, 1998). In the present study, following Rosenbaum and Lamort (1992), the scale disadvantage ratio, $SCALE\_DR_{it}$, is calculated as the ratio of output associated with producing at minimum efficient scale (MES) divided by the cost disadvantage ratio[17]. The advantage of this measure is that it

[17] See the Appendix to this chapter.

Table 4.9 Explanatory variables, used in the regression model, together with their definitions [a]

Variables	Definitions
Industry Specific Variables	
$PROFIT_{it}$	((Nominal gross output-Total cost) ÷Nominal gross output) for industry i in year t.
$GROWTH_{it}$	Ln (real gross output in year t ÷ real gross output in year t-1) for industry i.
EX_RATE_{it}	(Total employment loss due to exit in year t÷ total employment in year t-1) for industry i.
$SMALL\_FIRM_{it}$	Proportion of firms in industry i in year t with employment less than 100.
$SCALE\_DR_{it}$	Minimum efficient scale divided by cost disadvantage ratio for industry i in year t[b].
CAP_LAB_{it}	(Capital÷Labour) for industry i in year t.
$MULTI_{it}$	(Number of plants that belong to the multi-plant firms ÷ total number of plants) in industry i in year t.
$CONCENTRATION_{it}$	Herfindahl measure of concentration for industry i in year t.
$CYCLE_i$	Dummy variable equal to 1, if the industry i is in the first stage of its life cycle, 0 otherwise[c].
Geographical Specific Variables	
$DEMAND_{jt}$	LN(population $_t$÷ population $_{t-1}$) for region j.
$HOUSE_{jt}$	Proportion of owner occupied dwellings in region j in year t.
$SPECIALIZATION_{jt}$	Herfindahl measure of concentration for region j in year t[d].
$DENSITY_{jt}$	(Population÷area in square kilometre) for region j in year t.
$SMALL\_PLANT_{jt}$	(Employment of plants with less than 100 employees ÷ total employment) in region j in year t.
$UNEMPLOYMENT_{jt}$	ILO rate of unemployment for region j in year t.
$CORE\_REGION_j$	Dummy variable equal to 1, if the region j is one of the following regions: South East, South West, East Midlands and East Anglia, 0 otherwise.

Source: Data contained in the ARD is used to calculate all the independent variables, except for the information on population, proportion of owner occupied dwellings, area in square kilometre and ILO rate of unemployment, which have been collected from 'Regional Trends' (various issues).

[a] In addition to the above variables, 219 individual dummies (having 20 two-digit manufacturing sectors and 11 geographical regions, results in 220 (20×11) individuals) and 23 time dummies are also included in the model.

[b, c, d] See the Appendix to this chapter.

not only shows the level of output, associated with producing at MES, but also shows the extent of the disadvantage imposed on plants, due to producing at a level less than the MES. The expectation is that entry is lower in industries characterised with a high level of scale disadvantage ratio (Mayer and Chappell, 1992). CAP_LAB_{it} measures the extent of capital intensity in an industry and is also expected to encapsulate sunk costs. This variable is expected to discourage entry (Khemani and Shapiro, 1986). $MULTI_{it}$ measures the degree of multi-plant operation and, *ceteris paribus,* is expected to affect entry in a negative way (Mayer and Chappell, 1992). $CONCENTRATION_{it}$ measures the degree of seller concentration and can have either a positive or a negative impact on entry (Orr, 1974; Duestch, 1975). The last variable in the category of industrial specific variables is $CYCLE_i$, which is a dummy variable and shows the stage of the life cycle of an industry[18].

As for the geographical (regional) specific variables, $DEMAND_{jt}$ measures the degree of demand in the local area (in this case region). Population growth is used as a proxy for demand in the local area and is expected to affect entry in a positive way (Keeble and Walker, 1994). $HOUSE_{jt}$ measures the extent of owner occupied dwellings and has been found to effect entry in a positive direction (Fotopoulos and Spence, 1999). The Herfindahl measure of concentration in a region, $SPECIALIZATION_{jt}$[19], measures the degree of industrial specialization. This variable has been found to have a positive impact on entry (Garofoli, 1994). Population density, $DENSITY_{jt}$, is a proxy for the degree of agglomeration (or urbanization) in a region and is expected to have either a positive or a negative impact on entry (Guimaraes *et al.*, 1998; Armington and Acs, 2002). $SMALL\_PLANT_{jt}$ is a proxy for the local industrial structure and has been found

[18]Manufacturing sectors are divided into two categories, based on the median age of their plants: those in the first stage of their life cycle and those in the second stage. This is done by, initially, ranking the manufacturing sectors, based on the median age of their plants, from the lowest to the highest. Subsequently, the first 50% of the manufacturing sectors, having the smaller median age are grouped into one category, representing those industries in the first stage of their life cycle. Similarly, the second 50% of the manufacturing sectors, having the larger median age, are grouped into another category, representing those industries in the second stage of their life cycle. However, the grouping of the manufacturing sectors is based on the median age of their plants in the year 1995. The reason for this choice of year is that the entire history of the manufacturing sectors, since they were first introduced, is not available. The data goes back only to the year 1974, which, therefore, makes it impossible to obtain the exact age of the plants. Year 1995 is chosen, because it is towards the end of the period under study and, therefore, there is enough time for the identity of plants to change, due to natural turnover in the industries. This, therefore, gives a more realistic measure of the age of plants. The two-digit manufacturing sectors together with the stage of their life cycle are presented, in Table A4.16, in the Appendix to this chapter.

[19] Other measures have also been used in the literature, in order to measure the degree of specialization in an area (Fotopoulos and Spence, 1999). Following Devereux *et al.* (2001), in this study, the Herfindahl measure of industrial concentration is used, as it gives more sensible results. This measure is explained in the Appendix to this chapter.

to have a positive impact on new firm formation (Fritsch, 1992). The variable $UNEMPLOYMENT_{jt}$ measures the degree of unemployment in a region. Unemployment can either have a positive or a negative affect on entry, based on whether it pushes the individuals into starting their own business or shows a lack of buoyancy in the local economy (Reynolds *el al.* 1994; Garofoli, 1994). Finally, $CORE\_REGION_j$ is a dummy variable controlling for the geographical division between the north and the south of the U.K. This variable is included in order to capture the fundamental differences between the regions of the north and the south, which can result in differences in their entry rates (Gripaios *et al.* 2000). The minimum, maximum, mean and standard deviation of these explanatory variables are presented in Table 4.10.

Table 4.10 Minimum, Maximum, Mean and Standard Deviations of the explanatory variables

	Minimum	Maximum	Mean	Standard Deviation
Industry Specific Variables				
$PROFIT_{it}$	-4.832	0.258	-0.614	0.997
$GROWTH_{it}$	-2.392	1.488	-0.032	0.274
EX_RATE_{it}	0.000	0.481	0.047	0.055
$SMALL\_FIRM_{it}$	0.316	0.982	0.860	0.106
$SCALE\_DR_{it}$	0.003	3.805	0.114	0.321
CAP_LAB_{it}	0.002	0.112	0.020	0.019
$MULTI_{it}$	0.040	0.862	0.340	0.169
$CONCENTRATION_{it}$	0.005	0.804	0.072	0.095
$CYCLE_i$	0.000	1.000	0.500	0.500
Geographical Specific Variables				
$DEMAND_{jt}$	-0.395	0.057	0.001	0.025
$HOUSE_{jt}$	0.320	0.740	0.602	0.090
$SPECIALIZATION_{jt}$	0.094	0.357	0.140	0.052
$DENSITY_{jt}$	0.066	0.900	0.290	0.222
$SMALL\_PLANT_{jt}$	0.000	1.000	0.235	0.206
$UNEMPLOYMENT_{jt}$	1.600	19.400	9.163	3.877
$CORE\_REGION_j$	0.000	1.000	0.360	0.480

4.3.4 Entry model

The model used in this study is the GMM (Generalised Method of Moments) model, introduced by Arellano and Bover (1995). This choice was governed by the fact that the standard panel data models, such as fixed effect and random effect model, were not applicable. The reason is that the fixed effect model omits any time-invariant variable included in the model. In this study, both industry life cycle and core regional dummies are time-invariant. At the same time, the random effect model assumes that the differences across the individuals (in this case a manufacturing sector in a region) are random and therefore does not take account of the individual specific factors affecting entry rates. This is also a shortcoming, as entry rates are significantly higher/lower in certain manufacturing sectors and regions, due to some specific factors attached to either the manufacturing sector or the region. Therefore, the GMM approach, available in PcGive, is used in this study, since it is capable of taking account of the time-invariant variables. At the same time, individual dummies are included in the model, in order to take account of the fixed effects (individual specific factors) affecting the entry rates.

The model to be estimated is:

$$y^k_{ijt} = \text{Constant} + \alpha\, CYCLE_i + \beta\, CORE\_REGION_j + \gamma_1\, x_{it-1} + \gamma_2\,(x_{it-1} \times CYCLE_i) + \gamma_3\,(x_{it-1} \times CORE\_REGION_j) + \delta_1\, z_{jt-1} + \delta_2\,(z_{jt-1} \times CYCLE_i) + \delta_3\,(z_{jt-1} \times CORE\_REGION_j)$$
$$+ \sum_{i=1}^{19}\sum_{j=1}^{11}\theta_{ij}\,(Industry_i\ Region_j) + \sum_{j=1}^{10}\theta_{20j}\,(Industry_{20}\ Region_j) + \sum_{t=1}^{23}\lambda_t\, Time_t + u_{ijt} \qquad (1)$$

$$u_{ijt} = \alpha_{ij} + \gamma_t + v_{ijt} \qquad (i = 1,2\ldots20;\ j = 1,2\ldots11;\ t = 1,2\ldots24;\ k = 1,2,3)$$

$$E(v_{ijt}) = 0, \qquad E(v_{ijt})^2 = \sigma^2, \qquad E(v_{ijt}, v_{i'j't'}) = 0$$

y^k_{ijt} is defined as entry rate for the sub-group of entrants k in the industry i, region j and time t. $CYCLE_i$ and $CORE\_REGION_j$ are the stage of the life cycle and the geographical division dummies, respectively. x_{it-1} and z_{jt-1} are the lagged values of the industry specific and the regional specific variables, respectively, as explained in Table 4.9. Note that both the industry and the regional specific variables (the x's and the z's) are lagged. It is therefore assumed that entry is a lagged decision, which means that individuals make the decision to enter in a specific year based on the value of the explanatory variables in the previous year. A consequence of this model specification is that all the explanatory variables will be predetermined, which automatically eliminates the need for using instrumental variables with regard to the right hand side of equation (1). The error term is divided into three different components: α_{ij} is the individual specific component; γ_t is the time specific component; and v_{ijt} is an error term with the usual desirable Gaussian properties.

The effects of the industry life cycle and the geographical division are modelled not only separately, using the dummy variables in equation (1) ($CYCLE_i$ and $CORE\_REGION_j$), but also by multiplying each dummy by the explanatory variables ($x_{it-1} \times CYCLE_i$, $x_{it-1} \times CORE\_REGION_j$, $z_{jt-1} \times CYCLE_i$ and $z_{jt-1} \times CORE\_REGION_j$) to test for any composite effects of x_{it-1} and z_{jt-1} on entry rates, given the effect of the explanatory variables might vary across the two different stages of life cycle and the two major geographical divisions.

The term $\sum_{i=1}^{19}\sum_{j=1}^{11}\theta_{ij}\ (Industry_i\ Region_j) + \sum_{j=1}^{10}\theta_{20j}(Industry_{20}\ Region_j)$ is included in the model in order to take account of the individual specific factors (fixed effects) affecting the entry rates[20]. These dummies allow for the intercept to vary for each individual. Finally, $\sum_{t=1}^{23}\lambda_t\ Time_t$ are the time dummies that take account of the time specific factors

[20] As there are 220 individuals (20 industries in 11 geographical regions), only 219 dummy variables have to be included in the model. Therefore, $Industry_{20}\ Region_{11}$ is dropped out of the equation.

affecting the entry rates. The expected signs of the coefficients associated with the explanatory variables in equation (1) are presented in Table 4.11.

Table 4.11 Variables and the expected sign of their coefficients

Variables	Expected Signs
Industry Specific Variables	
$PROFIT_{it-1}$	+
$GROWTH_{it-1}$	+
EX_RATE_{it-1}	+
$SMALL\_FIRM_{it-1}$	+
$SCALE\_DR_{it-1}$	-
CAP_LAB_{it-1}	-
$MULTI_{it-1}$	-
$CONCENTRATION_{it-1}$	?
$CYCLE_{i}$	?
Geographical Specific Variables	
$DEMAND_{jt-1}$	+
$HOUSE_{jt-1}$	+
$SPECIALIZATION_{jt-1}$	+
$DENSITY_{jt-1}$	?
$SMALL\_PLANT_{jt-1}$	+
$UNEMPLOYMENT_{jt-1}$	?
$CORE\_REGION_{j}$	?

4.3.5 Results

Before running the model, the bivariate correlations between the explanatory variables needs to be examined, in order to determine the possibilities for multi-colinearity. Therefore, the bivariate correlations between each pair of the industry specific and the regional specific variables are presented in Tables 4.12 and 4.13, respectively. The correlations between the geographical specific variables are low. However, there are some significantly high correlations observed between the industry specific variables, especially the variable $MULTI_{it-1}$ which shows a high correlation with the variables $SMALL\_FIRM_{it-1}$ and CAP_LAB_{it-1}. The high correlation between the variable $MULTI_{it-1}$ and $SMALL\_FIRM_{it-1}$ is expected, due to the way in which these two variables are calculated[21].

[21] Large firms are more likely to be a multi-plant firm than are small firms.

Table 4.12 Correlations between the industry specific variables, over 1974-97

	$PROFIT_{it}$	$GROWTH_{it}$	EX_RATE_{it}	$SMALL\_FIRM_{it}$	$SCALE\_DR_{it}$	CAP_LAB_{it}	$MULTI_{it}$	$CONCENTRATION_{it}$
$PROFIT_{it}$	1.000							
$GROWTH_{it}$	-0.005	1.000						
EX_RATE_{it}	0.359*	-0.166*	1.000					
$SMALL\_FIRM_{it}$	0.201*	0.024	0.193*	1.000				
$SCALE\_DR_{it}$	0.107*	-0.151*	0.133*	-0.190*	1.000			
CAP_LAB_{it}	0.254*	0.023	0.084*	-0.434*	0.163*	1.000		
$MULTI_{it}$	-0.136*	-0.039*	-0.109*	-0.682*	0.194*	0.651*	1.000	
$CONCENTRATION_{it}$	0.097*	-0.057*	-0.032*	-0.621*	0.630*	0.479*	0.542*	1.000

*means that the correlation is significant at 1% level of significance (2 tailed).

Table 4.13 Correlations between the geographical specific variables, over 1974-97

	$DEMAND_{jt}$	$HOUSE_{jt}$	$SPECIALIZATION_{jt}$	$DENSITY_{jt}$	$SMALL\_PLANT_{jt}$	$UNEMPLOYMENT_{jt}$
$DEMAND_{jt}$	1.000					
$HOUSE_{jt}$	0.090*	1.000				
$SPECIALIZATION_{jt}$	0.089*	-0.002	1.000			
$DENSITY_{jt}$	-0.074*	0.211*	-0.038*	1.000		
$SMALL\_PLANT_{jt}$	-0.015	0.041*	-0.267*	-.085*	1.000	
$UNEMPLOYMENT_{jt}$	0.011	0.086*	0.020	-.076*	.024**	1.000

* and ** mean that the correlation is significant at 1% and 5% level of significance (2 tailed), respectively.

The dependent variable is calculated separately for each category of entrants (plants opened by domestic de-novo firms, plants opened by domestic incumbents and plants opened by foreign firms). Equation (1) was initially applied separately to each different category of entrants. However, not all the explanatory variables were included in all the equations. The variables $HOUSE_{jt-1}$ and $SMALL\_PLANT_{jt-1}$ were included only when the dependent variable was entry by domestic de-novo firms. The reason for their exclusion from the other two equations was that there was no theoretical justification behind including them. $HOUSE_{jt-1}$ is used as a proxy for personal wealth, which can be used as a collateral for starting a new business. This naturally does not apply to entry by domestic incumbents and foreign firms. Similarly, $SMALL\_PLANT_{jt-1}$ is only included when examining the entry by domestic de-novo firms, as small plants are a better incubator for new businesses. Therefore, it is presumed not have any impact on entry by domestic incumbents and foreign firms.

The variable $MULTI_{it-1}$ was dropped from all three equations, due to creating a severe multicollinearity. This was a result of its high correlation with the variables $SMALL\_FIRM_{it-1}$ and CAP_LAB_{it-1}. Next, using a general to specific modelling strategy, only the significant interaction terms were kept in the equations. The final models are presented in Table 4.14. A comparison between the results reveals that the different sub-groups of entrants respond differently to the same explanatory variables. By way of illustrating the results, the elasticities for the mechanical engineering industry in the South East region of the U.K. in 1994, are calculated and presented in Table 4.15[22]. In this example, the coefficients are calculated based on the two dummies (the industry life cycle and the geographical division dummy) having a value of one. The reason is that,

[22] The choice of industry, region and year in this example is completely arbitrary and it is just for the ease of interpretation. Elasticities are then calculated as, coefficient × (x/y), where x is the value of the explanatory variable in 1993 (as the explanatory variables are one year lagged) and y is entry rate for a given group of entrants, in the mechanical engineering industry, in the South East region in 1994.

Table 4.14 Results of running the GMM model, for the three different groups of entrants (1974-97)

	Coefficients		
Variables	Domestic de-novo firms	Domestic incumbents	Foreign firms
$PROFIT_{it-1}$	0.002 (2.51)**	0.006 (2.75)*	0.0009 (1.03)
$PROFIT_{it-1}$ * $CYCLE_i$	0.003 (2.75)*	n.s	n.s
$PROFIT_{it-1}$ * $CORE\_REGION_j$	n.s	n.s	n.s
$GROWTH_{it-1}$	0.003 (1.45)	-0.012 (-3.01)*	-0.002 (-0.814)
$GROWTH_{it-1}$ * $CYCLE_i$	n.s	n.s	n.s
$GROWTH_{it-1}$ * $CORE\_REGION_j$	n.s	0.011 (2.01)**	0.007 (1.70)***
EX_RATE_{it-1}	0.003 (0.19)	0.057 (2.18)**	0.081 (1.65)***
EX_RATE_{it-1} * $CYCLE_i$	n.s	-0.096 (-1.88)***	n.s
EX_RATE_{it-1} * $CORE\_REGION_j$	n.s	n.s	n.s
$SMALL\_FIRM_{it-1}$	0.008 (2.59)*	0.0217 (2.93)*	-0.02 (-2.62)*
$SMALL\_FIRM_{it-1}$ * $CYCLE_i$	0.004 (2.94)*	-0.0216 (-3.15)*	n.s
$SMALL\_FIRM_{it-1}$ * $CORE\_REGION_j$	n.s	n.s	n.s
$SCALE\_DR_{it-1}$	-0.006 (-3.70)*	0.005 (0.766)	0.020 (2.84)*
$SCALE\_DR_{it-1}$ * $CYCLE_i$	0.008 (1.70)***	n.s	n.s
$SCALE\_DR_{it-1}$ * $CORE\_REGION_j$	n.s	n.s	n.s
CAP_LAB_{it-1}	-0.006 (-3.18)*	0.014 (3.93)*	0.003 (2.34)**
CAP_LAB_{it-1} * $CYCLE_i$	-0.007 (-14.1)*	0.003 (2.10)**	n.s
CAP_LAB_{it-1} * $CORE\_REGION_j$	-0.001 (-2.11)**	0.007 (6.84)*	0.003 (2.85)*
$CONCENTRATION_{it-1}$	-0.003 (-0.50)	-0.006 (-0.415)	-0.001 (-0.110)
$CONCENTRATION_{it-1}$ * $CYCLE_i$	0.01 (2.03)**	n.s	0.011 (2.85)*
$CONCENTRATION_{it-1}$ * $CORE\_REGION_j$	n.s	-0.022 (-3.35)*	n.s
$DEMAND_{jt-1}$	-0.008 (-0.98)	0.016 (2.24)**	0.004 (1.28)
$DEMAND_{jt-1}$ * $CYCLE_i$	n.s	n.s	n.s
$DEMAND_{jt-1}$ * $CORE\_REGION_j$	0.016 (3.09)*	n.s	n.s
$HOUSE_{jt1}$	0.004 (1.34)		
$HOUSE_{jt1}$ * $CYCLE_i$	n.s		
$HOUSE_{jt-1}$ * $CORE\_REGION_j$	0.024 (3.18)*		
$SPECIALIZATION_{jt-1}$	0.023 (7.51)*	-0.022 (-5.45)*	0.002 (0.773)
$SPECIALIZATION_{jt-1}$ * $CYCLE_i$	0.004 (2.30)**	n.s	n.s
$SPECIALIZATION_{jt-1}$ * $CORE\_REGION_j$	-0.027 (-3.21)*	n.s	-0.004 (-2.45)**
$DENSITY_{jt-1}$	-0.005 (-6.39)*	-0.005 (-3.63)*	0.008 (7.16)*
$DENSITY_{jt-1}$ * $CYCLE_i$	0.003 (9.65)*	0.008 (8.12)*	-0.025 (-8.29)*
$DENSITY_{jt-1}$ * $CORE\_REGION_j$	-0.014 (-2.70)*	n.s	n.s
$SMALL\_PLANT_{jt-1}$	0.013 (4.45)*		
$SMALL\_PLANT_{jt-1}$ * $CYCLE_i$	n.s		
$SMALL\_PLANT_{jt-1}$ * $CORE\_REGION_j$	0.010 (2.55)**		
$UNEMPLOYMENT_{jt-1}$	-0.001 (-3.20)*	-0.0015 (-1.69)***	-0.0007 (-1.80)***
$UNEMPLOYMENT_{jt-1}$ * $CYCLE_i$	n.s	0.0012 (2.99)*	n.s
$UNEMPLOYMENT_{jt-1}$ * $CORE\_REGION_j$	n.s	n.s	n.s
$CYCLE_i$	0.0002 (0.200)	0.010 (1.56)	0.018 (9.84)*
$CORE\_REGION_j$	-0.015 (-4.03)*	0.0006 (0.160)	-0.0002 (-0.217)

Figures in parentheses are t-statistics.*, ** and *** denote that coefficients are statistically significant at 1%, 5% and 10% level of significance, respectively.

Table 4.15 Elasticities calculated for the mechanical engineering industry, in the South East region of the U.K. in 1994

	Elasticities		
Variables	Domestic de-novo firms	Domestic incumbents	Foreign firms
$PROFIT_{it-1}$	2.40%	2.37%	0.38%
$GROWTH_{it-1}$	0.34%	-0.10%	0.42%
EX_RATE_{it-1}	0.68%	-6.05%	14.04%
$SMALL\_FIRM_{it-1}$	40.91%	0.13%	-58.28%
$SCALE\_DR_{it-1}$	0.05%	0.09%	0.37%
CAP_LAB_{it-1}	-0.71%	0.98%	0.32%
$CONCENTRATION_{it-1}$	0.17%	-0.60%	0.24%
$DEMAND_{jt-1}$	0.09%	0.16%	0.05%
$HOUSE_{jt1}$	62.58%		
$SPECIALIZATION_{jt-1}$	0.31%	-6.57%	-0.59%
$DENSITY_{jt-1}$	-20.23%	2.55%	-19.47%
$SMALL\_PLANT_{jt-1}$	20.03%		
$UNEMPLOYMENT_{jt-1}$	-33.91%	-7.68%	-18.09%

Elasticities are calculated as, coefficient × (x / y), where x is the value of the explanatory variable in year 1993 (as the explanatory variables are one year lagged) and y is entry rate for a given group of entrants, in the mechanical engineering industry, in the South East region, in 1994.

based on the median age of its plants, the mechanical engineering industry is categorised as being in the first stage of its life cycle (see Table A4.16). At the same time, the South East region is located in the South, which gives a value of 1 to the geographical division dummy.

Starting from the variable $PROFIT_{it-1}$ in Table 4.14, it is clear that it has a different impact on entry by different groups of entrants. Both domestic de-novo firms and domestic incumbents respond positively to increased profits, while this effect is insignificant on foreign entry. For the domestic de-novo firms, the positive effect is even stronger, if they are entering into an industry in the first stage of its life cycle. Based on the model introduced by Gort and Klepper (1982), in young industries prices of the products are initially high, due to the small number of firms producing them. Subsequently, as entry increases, the number of firms and industry output increases, which results in a reduction in prices. They explained that, as industries enter the mature stages of their life cycle, the rate of growth in output drops below that of an average firm. At this stage, exit is inevitable and shakeout happens.

Based on this model, it is clear that increased profits, in the second stage of the industry's life cycle, coexist with a high level of concentration, which is usually difficult to be overcome by de-novo firms. However, in the first stage, when competition is important, increased profits could be a sign of more market opportunities. This can be the reason for the stronger effect of profits on de-novo entry in the first stage of an industry's life cycle. These results are similar to the findings by Khemani and Shapiro (1988), in that they also found that industry profit had a positive impact on entry by de-novo firms. Mata (1993) found that the only kind of entry that responded positively to industry profits was expansion entry. The reason proposed by him was that, for firms already established in an industry, past profits are better proxies for the future profits, since they are generated by them.

On the other hand, in Table 4.14 it is shown that past profits did not have any impact on entry by foreign firms. This finding is similar to the finding by Geroski (1991a). He found that only domestic entrants responded positively to profit opportunities. He suggested the following three reasons for this effect: 1) adjustment costs for foreign firms are usually higher than for domestic firms, which results is a quicker response to profit opportunities from domestic producers; 2) incumbents' reaction is milder to domestic entry than to foreign entry; and 3) the elasticity of demand for the product of the domestic firms is higher than that for foreign firms.

Taking the mechanical engineering industry in the South East region in 1994 (see Table 4.15), one can see that a 1% increase in the lagged profits increased entry (the plant opening) rate by domestic de-novo firms and domestic incumbents by 2.4% and 2.37%, respectively.

$GROWTH_{it-1}$ does not have any significant impact on entry by domestic de-novo firms. Mata (1993) found a similar result. It appears that for de-novo entrants, past profits were better proxies for future profits than past industry growth. On the other hand, lagged industry growth has a negative impact on plant opening by domestic incumbents in the northern regions of the U.K. However, this effect in the regions of the south is very small and almost equal to zero. In Section 4.3.3 it was explained that due to the unavailability of the equilibrium values of demand, the output values were used in order to calculate industry growth. However, this can have a different implication for the effect of past industry growth on entry. In this case, a higher growth rate of output could indicate that there is less room available in a market for new entrants, which can subsequently retard plant opening by domestic incumbents rather than inducing it. Lieberman (1990) found that incumbents set a higher capacity expansion threshold for new plants than did entrants. This implies that incumbents only build new plants when there is a need for additional capacity; otherwise, they just expand production within their existing plants. However, a greater potential market in the south (as a result of its larger population) to some extent can lessen this negative effect.

Geroski (1991a) also found that lagged industry growth had a negative impact on domestic entry. However, Orr (1974), Hause and Du Rietz (1984), Khemani and Shapiro (1986), Highfield and Smiley (1987), Chappell *et al.* (1990), Schwalbach (1991) and Mayer and Chappell (1992) found a positive impact of industry growth on entry. Our findings also contradict the previous findings by Baldwin and Gorecki (1987) and Khemani and Shapiro (1988). Baldwin and Gorecki found that industry growth had a positive impact on entry by domestic de-novo firms and Khemani and Shapiro found that it had a positive impact on different kinds of domestic entry.

In this study, the only group of entrants that respond positively to industry growth are foreign firms, although this effect is present only when foreign firms are entering into the core regions of the south. This is in accordance with the finding by Gorecki (1975), in that he also found that only foreign entrants responded positively to industry growth. However, Baldwin and Gorecki (1987) and Khemani and Shapiro (1988) found no significant effect of industry growth on entry by foreign firms. In terms of the elasticities, reported in Table 4.15 for our representative case, a 1% increase in lagged industry growth decreased the plant entry rate by incumbents, in the mechanical engineering industry in the South East in 1994, by 0.1% and increased plant entry rate by foreign firms by 0.4%.

EX_RATE_{it-1} has no significant impact on entry by domestic de-novo firms. The possible reason for this effect could be that due to their small scale and operating in market niches, de-novo entrants do not impact upon total industry output significantly and, therefore, do not respond to the room created at the industry level. On the other hand, this variable seems to encourage plant opening by domestic incumbents, although the direction of the effect depends on the stage in an industry's life cycle. In industries in the first stage of their life cycle, the room created due to previous exits has a negative impact on entry by domestic incumbents, while in the second stage it has a positive impact. This effect can be explained by the theory proposed by Klepper (1996). He explained that in the second stage of an industry's life cycle, as the nature of innovation is changing from product to process innovation, size creates an advantage for incumbents. Hence, at this stage incumbents respond positively to the vacuum created due to previous exits as larger size brings them advantages. However, in the first stage, the room created in the market has a negative impact on capacity expansion by multi-plant firms, as it can be just a sign of a highly turbulent environment.

The only category of entrants that respond unconditionally positively to the room created at the industry level, due to previous exits, are foreign firms. Table 4.15 shows that in the mechanical engineering industry in the South East in 1994, a 1% increase in

EX_RATE$_{it-1}$ decreased the rate of plant opening by domestic incumbents by 6.05%, while it increased the rate of plant opening by foreign firms by 14.04%.

The variable *SMALL_FIRM*$_{it-1}$ is found to have a positive impact on entry by domestic de-novo firms and domestic incumbents. Dunne *et al.* (1988) found that the majority of entries and exits that takes place in an industry are among the small firms. Rosenbaum and Lamort (1992) also found that existence of small firms in an industry had a positive impact on entry. However, the associated impact is stronger for domestic de-novo firms in the first stage of an industry's life cycle, and for domestic incumbents in the second stage.

Agarwal and Audretsch (2001) stated that the role of small firms varies through various stages of the industry life cycle. They explained that the existence of small firm in the first stage is because these firms are competing for the dominant design and thus their likelihood of success is low. However in the second stage, when the dominant design has emerged, the existence of small firms is more in order to occupy strategic niches. This theory shows that based on the stage of the industry life cycle, the existence of small firms in an industry can signal different market conditions. In the first stage it signals a high level of competition and a turbulent environment, which subsequently can attract de-novo entrants, while for the incumbents the opposite is true.

Finally, foreign entry occurs less in industries dominated by small firms. Caves (1971) proposed that foreign firms possess some advantages relative to domestic firms which enables them to overcome the entry barriers identified by Bain (1956). These advantages are: 1) if economies of scale are present at a particular stage of production, a multi-national firm can carry out that stage at a single location and transfer the rest of the stages to its subsidiaries; 2) if the product differentiation barrier is present and created through patenting, then a multi-national enterprise can use its knowledge to serve markets across its national boundaries. On the other hand, if product differentiation is created through advertising, not only does advertising spill across the national boundaries, but also previous advertising creates an accumulated knowledge, which can be used for marketing of the products abroad and adapting them according to the consumers' tastes and 3) foreign firms have the advantage of buying factors of production either in the host or the home country, while domestic entrants have to chose only from one set of factor prices in their home country. Having these advantages, foreign firms tend to enter industries with high entry barriers, which are usually less populated by small firms.

In terms of our example in Table 4.15, a 1% increase in $SMALL\_FIRM_{it-1}$ in the mechanical engineering industry in the South East region in 1994, increased the rate of plant opening by domestic de-novo firms and domestic incumbents by 40% and 0.13%, respectively, while it decreased plant opening rate by foreign firms by 58%[23].

$SCALE\_DR_{it-1}$ has a positive impact on plant opening by domestic de-novo firms, if plants are opening in industries in the first stage of their life cycle. However, if they are entering into industries in the second stage of their life cycle, $SCALE\_DR_{it-1}$ has a negative impact. Klepper (1996) showed that in the second stage of the industry life cycle, process innovation replaces product innovation. In this stage having larger plants creates an advantage for the owner firms engaged in process innovation. This puts the entrants at a cost disadvantage, relative to the incumbents, if they are to enter at a small scale. Based on this theory, it is evident that due to their small initial sizes de-novo entrants are deterred from entry into industries in the second stage of their life cycle, characterised by a high degree of the scale disadvantage ratio. However, we find no

[23] As it was explained in Footnote 20, elasticities are calculated as, coefficient × (x / y), where x is the value of the explanatory variable in year 1993 and y is the entry rate for a given group of entrants, in the mechanical engineering industry, in the South East region in 1994. The reason for the high elasticities in the case of entry by domestic de-novo firms and entry by foreign firms is the high coefficients and the high proportion of small firms in the mechanical engineering industry in 1993. However, as the associated coefficient for domestic incumbents is very small (0.0001), it decreases the elasticity for this group.

support for the associated impact in the first stage of industry life cycle. Harris (1976), Hause and Du Rietz (1984), Chappell *et al.* (1990) and Mayer and Chappell (1992) all found that existence of economies of scale in industries had a negative impact on entry. Khemani and Shapiro (1988) and Mata (1993) both found that de-novo entrants were deterred from entering into industries where a high degree of economies of scale was present.

$SCALE\_DR_{it-1}$ has no significant impact on expansion decisions by domestic incumbents (in terms of plant opening). However, it has a positive impact on plant opening by foreign firms. The associated reasons for this impact were explained earlier when looking at the effect of $SMALL\_FIRM_{it-1}$ on entry by foreign firms. According to Caves (1971), due to the advantages that foreign firms possess they prefer industries with high entry barriers. As the presence of a scale disadvantage ratio in industries is a structural entry barrier, it attracts entry by foreign firms. Khemani and Shapiro (1988) also found that foreign entrants were not affected by the presence of scale economies in industries. In terms of the example in Table 4.15, a 1% increase in $SCALE\_DR_{it-1}$ in the mechanical engineering industry in the South East region in 1994, increased the plant opening rate by de-novo firms by 0.05% and plant opening rate by foreign firms by 0.37%.

CAP_LAB_{it-1} has a negative impact on entry by de-novo firms and the impact is stronger when they are entering into industries in the first stage of their life cycle or when they are entering into the core regions of the south. In contrast, CAP_LAB_{it-1} has a positive impact on entry by domestic incumbents. This positive impact is also stronger if they are entering into industries in the first stage of their life cycle or in the core regions of the south. The reason for a different impact of CAP_LAB_{it-1} on entry by domestic de-novo firms and domestic incumbents is likely to be the imperfection of capital markets. Demsetz (1982) explained that incumbents' history conveys information about their ability to accept any unforeseen risk, which affects the interest payments required by lenders. As a result, older and larger firms can borrow capital at a cheaper price than newer firms. Therefore, according to Demsetz, in a world where information is costly the major source of interest rate differential is the history attached to a successful firm. Mata (1993) found a negative impact of capital intensity on the entry by de-novo firms. Khemani and Shapiro (1988) also found the same result. However, they found that capital intensity did not have any significant impact on entry by already established firms.

In the present study, it was also found that the associated effects are stronger in the first stage of the industry's life cycle and in the core regions of the south. According to Abernathy and Utterback (1978), in the first stage of the industry's life cycle there is usually a high degree of uncertainty regarding the success of the new ventures. Therefore, this can increase the risk of investment by de-novo entrants, especially if a significant amount of capital is sunk. Similarly, it gives the incumbents a relative advantage in terms being able to borrow the start-up capital. On the other hand, Harris and Andrew (2000) found that the rate of return on capital is higher in the south, which increases the opportunity cost of capital. Therefore, this makes it even more difficult for the de-novo entrants to borrow start-up capital, if they are entering into the core regions of the south.

CAP_LAB_{it-1} has a positive impact on entry by foreign firms, which is stronger if they are building plants in the core regions of the south. This is again likely to be linked to a foreign firm's ability to overcome various entry barriers. In terms of the elasticities shown in Table 4.15, a 1% increase in CAP_LAB_{it-1} in the mechanical engineering industry in the South East region in 1994, decreased the rate of plant opening by de-novo firms by 0.71%, while it increased the rate of plant opening by incumbents and foreign firms by 0.98% and 0.32%, respectively.

The last variable, in the category of industry specific variables, is $CONCENTRATION_{it-1}$. Our findings suggest that, *ceteris paribus*, more concentrated industries in the first stage of their life cycle face higher rates of entry by de-novo firms. The models introduced by Gort and Klepper (1982) and Agarwal (1998) suggested that in the early stages of industry life cycle there is a large amount of information available, which encourages new firms to enter the market. Subsequently, as the market grows, the number of firms and output increases. They explained that as the dominant technology emerges a shake out in the number of firms occurs, and the least efficient firms exit. In the next stage, where the market is more mature, product design standardises and price and quantity also stabilises. In the present study it was found that high concentration in the first stage of industry life cycle can attract entry by de-novo firms. As was explained above, the nature of concentration at this stage is very different from that in the second stage, when there are widespread collusive activities by incumbents. In the first stage, high concentration can be due to the market not being exposed to many firms. This, subsequently, can attract entry by de-novo firms. This finding contradicts the previous findings by Khemani and Shapiro (1988), in that they found a negative impact of concentration on entry by de-novo firms.

The effect of concentration on the entry by incumbents is insignificant if they are building new plants in the regions of the north. However, concentration has a negative impact on their entry, if they are setting-up plants in the core regions of the south. On the other hand, foreign firms are more attracted to highly concentrated industries in the first stage of their life cycle. Highly concentrated industries are usually also characterised with having high entry barriers which, as was discussed previously, attracts entry by foreign firms. However, the reason for the existence of this positive effect only in the first stage could be that a high concentration in this stage signals more profitable opportunities in the future and less retaliatory actions from incumbents in face of foreign entry. Gorecki (1975) found that concentration had no significant impact on entry by foreign firms. In terms of the example in Table 4.15, a 1% increase in $CONCENTRATION_{it-1}$ in the mechanical engineering industry in the South East region in 1994, increased plant entry rate by de-novo firms and foreign firms by 0.17% and 0.24%, respectively, while it decreased the plant entry rate by domestic incumbents by 0.6%.

The first regional specific variable, in Table 4.14, is $DEMAND_{jt-1}$. It is found that increases in demand in a region has a positive impact on entry by domestic de-novo firms. However, this effect was present only in the core regions of the south, while in the regions of the north this effect was insignificant. On the other hand, demand increase in a region always has a positive impact on plant opening by domestic incumbents in that region. The positive impact of regional demand on entry has been found in the following studies: Fritsch (1992) and Armington and Acs (2002). Foreign firms were the only category of entrants, where their plant opening decision was not dependent on the local demand. In previous empirical studies, the size of the host market has usually been found to have a positive impact on inward foreign direct investment (Friedman *et al.*, 1992; Billington, 1999). However, Scaperlanda and Mauer's (1969) found no such significant impact. Table 4.15 shows that a 1% increase in regional demand, increased plant entry rate by domestic de-novo firms and domestic incumbents, in the mechanical engineering industry in the South East region in 1994, by 0.09% and 0.16%, respectively.

As was explained earlier in this section, $HOUSE_{jt1}$ is included only in the first equation. Being a proxy for the degree of house ownership in a region, this variable is found to have a positive impact on plant opening by domestic de-novo firms. The reason for this positive impact is that individuals can use it as a collateral in order to start a new business. Fotopolous and Spence (1999) also found a positive impact of house ownership on new firm formation. However, this effect is confined only to the core regions of the south. The reason could be the existence of a regional selective assistance (RSA) scheme in the north. The RSA encourages new business start-up in the north and provides them with the start-up capital. This scheme generally does not apply to the new business start-ups in the south. Therefore, individuals in the south have to finance the start-up capital mainly through their personal wealth. Table 4.15 shows that a 1% increase in $HOUSE_{jt-1}$, increased the rate of plant opening by domestic de-novo firms, in the mechanical engineering industry in the South East region in 1994, by 62.6%.

The effect of $SPECIALIZATION_{jt-1}$ on entry by domestic de-novo firms is conditional on the stage of industry life cycle and the geographical location of the new plant. Area specialisation has a positive impact on entry by domestic de-novo firms, except if they are entering into an industry in the second stage of its life cycle and into the core regions of the south.

Krugman (1991b) proposed that specialization contributes to the existence of external economies of scale in an area and specialized areas are attractive locations for new business start-ups, as specialisation: 1) increases productivity; 2) lowers the cost of intermediate inputs and 3) facilitates technological spill-over, as a result of knowledge spill-over from other high technology companies, and also facilitates information circulation. However, Gudgin (1978) contended that the higher the level of diversification, the higher is the number of new firms. The reason proposed by him was that a higher level of diversification indicates a higher variety of skills available locally.

Garofoli (1994) and Fotopoulos and Spence (1999) found that area specialization had a positive impact on entry. Our findings show that de-novo firms, having no prior experience in industries, always benefit from area specialization, except when they are entering into an old industry (being in the second stage of its life cycle) and into one of the core regions of the south. In this case they prefer a more diversified region.

Area specialization has a negative impact on plant opening by domestic incumbents. Therefore, it appears that this category of entrants, having prior experiences in industries, do not benefit as much from the external economies of scale created as a result of area specialization. In contrast, they are more attracted to diversified areas. The impact of area specialization on foreign entry is negative, although this impact is significant only in the core regions of the south. Therefore, these groups of entrants are, also, more attracted to the diversified regions, but only in the core regions of the south. Table 4.15 shows that a 1% increase in $SPECIALIZATION_{jt-1}$ increased plant opening by domestic de-novo firms in the mechanical engineering industry in the South East region in 1994, by 0.31%, while it decreased plant opening by domestic incumbents and foreign firms by 6.5% and 0.59%, respectively.

$DENSITY_{jt-1}$ always has a negative impact on entry by domestic de-novo firms, and the effect is even stronger if they are entering into the core regions of the south or an industry in the second stage of its life cycle. Population density is used here as a proxy for the agglomeration (or urbanization) economies. The associated negative impact can be due to the high start-up costs (e.g. land prices) of a new business in the highly dense areas. This is likely to be the reason, as this effect is even stronger in the core regions of the south. However, this negative impact lessens to some extent if the target industry is a relatively young industry (which means that it is in the first stage of its life cycle). The reason can be associated with the merits of the dense areas, in terms of providing a better market for new businesses, which can be important for the young industries, as they face higher uncertainty relative to the old industries. Guimaraes *et al.* (1998) also found a negative impact of density on new firm formation. Looking at the trend in geographic concentration of firms in certain regions of the United States, Dumais *et al.* (1997) found that new entrant chose to enter the less concentrated regions. The reason proposed by them was that in such areas the benefits from concentration were offset by the disadvantages associated with high urban densities and congestion problems. On the contrary, Armington and Acs (2002) found that industrial density (a proxy for agglomeration economies) had a positive impact on entry.

Density has a positive impact on entry by domestic incumbents, if they are opening new plants in relatively young industries, and has a negative impact if they are opening plants in relatively old industries. As it was explained above, highly dense areas provide a better market for businesses, which can be more important if an industry is relatively young. The possible reason for our finding is that incumbents, due to having more resources, can overcome the higher start-up costs of new plants in the dense areas and take advantage of the agglomeration (or urbanization) economies if they are entering into a young industry. However, if they want to enter an old industry, density has the opposite effect.

However, density has a positive impact on entry by foreign firms, if they are entering an old industry, and a negative impact if they are entering a young industry. Billington (1999) found that population density had a positive impact on foreign direct investments in the UK. However, we found that this impact is present only when the target industry is relatively old. Table 4.15 shows that a 1% increase in $DENSITY_{jt-1}$, decreased the plant opening rate by domestic de-novo firms and foreign firms, in the mechanical engineering industry in the South East region in 1994, by 20.2% and 19.5% respectively; while it increased plant opening rate by domestic incumbents by 2.6%.

$SMALL\_PLANT_{jt-1}$ is included only in the first equation, due to the reason discussed at the beginning of this section. It was found that a larger population of small plants in an area affects plant opening by domestic de-novo firms positively, and the effect is even stronger in the core regions of the south. This is in accordance with the findings by Fritsch (1992), Garofoli (1994) and Fotopoulos and Spence (1999). They found also that the existence of small plants in an area had a positive impact on entry by new firms. The reasons proposed by Mason (1991), Storey (1981) and Storey (1982) for this positive effect are as follows: 1) small plants provide their employees with a better work experience; 2) in small plants, employees can have a closer contact with the managers of the company, which increases their confidence, and 3) job security is lower is small plants, which can push individuals into starting their own businesses.

However, this effect was found to be stronger in the regions of the south. The reasons for this effect can be seen in the different market conditions, labour-force characteristics, industry composition and fixed regional specific factors, that makes regions in the south of Britain more entrepreneurial than the regions of the north (Georgellis and Wall, 2000). Table 4.15 shows that a 1% increase in $SMALL\_PLANT_{jt-1}$ increased plant entry rate by domestic de-novo firms, in the mechanical engineering industry in the South East region in 1994, by 20%.

The last geographical specific variable in Table 4.14 is $UNEMPLOYMENT_{jt-1}$. We find no support for the proposition that due to unavailability of alternative jobs in areas with a high level of unemployment, individuals are pushed into starting their own business (the unemployment push effect). On the contrary this study found that new business start-ups are higher in regions with a lower level of unemployment. Fritsch (1992) and Garofolli (1994) also found that unemployment in an area had a negative impact on new firm formations. However, Armington and Acs (2002) found that unemployment in an area had a positive impact on the formation of new businesses.

Similarly, incumbents tend to open their new plants in regions with a lower level of unemployment, although the associated impact is very small (almost equal to zero) if they are opening their new plants in young industries. Finally, foreign firms prefer to enter regions with a lower level of unemployment. The reason for this negative impact can be that a high level of unemployment is an area indicates erosion of the workforce, which *ceteris paribus* makes the area unattractive for foreign entry. This finding contradicts the previous findings by Friedman *et al.* (1992) and Billington (1999), in that they found the opposite. In Table 4.15, a 1% increase in unemployment in the region, decreased plant opening by domestic de-novo firms, domestic incumbents and foreign firms, in the mechanical engineering industries in the South East region in 1994, by 33.9%, 7.7% and 18.1%, respectively.

4.4 Summary and Conclusions

In this chapter, entry (plant opening) decision of firms in U.K. manufacturing industries over the 1974-97 period was studied. Entrants (new plants) were divided into three different categories: 1) new plants opened by domestic de-novo firms; 2) new plants opened by domestic incumbents; and 3) new plants opened by foreign firms. Their entry decisions were studied separately. The entry determinants were divided into two categories: 1) industry specific factors and 2) geographical specific factors. The effect of the explanatory variables on entry was allowed to vary across the two different stages in their industry life cycle and the two geographical segments, the north and the south of UK, and the following results were found.

Domestic de-novo entrants took past industry profit as a better proxy for future profitability of the industries than past industry growth. At the same time, the positive effect of past industry profit on their entry was stronger if the target industry was in the first stage of its life cycle. Similarly, they were encouraged to enter industries with a large population of small firms. This effect was also stronger if the target industry was in the first stage of its life cycle. This group of entrants, due to their small size and operating in market niches, were not responsive to the room created in industries due to previous exits. Highly concentrated industries in the first stage of their life cycle encouraged their entry as they signalled future profit opportunities.

On the contrary, they were deterred from entry into capital intensive industries. This effect was found to be stronger if the target industry was in the first stage of its life cycle or if the target region was located in the south of the UK. This group of entrants were deterred from entry into industries characterised with a high scale disadvantage ratio in the second stage of their life cycle, but encouraged to enter into such industries in the first stage of their life cycle.

Regional demand had a positive impact on their entry, as domestic de-novo firms usually serve local markets. The degree of house ownership in a region also had a positive impact on their entry. Therefore, this group of entrants used their house ownership status as a collateral to raise the start-up capital in the south of the UK, whereas in the north they are able to benefit from governments assistance schemes such as regional selective assistance (RSA). However, the effect of regional demand and house ownership was present only in the core regions of the south. The size of the incubator plants in the region had a positive impact on their entry and this effect was found to be stronger if entry was into one of the core regions of the south.

Population density had a negative impact on entry. This negative effect was stronger if the target region was one of the core regions of the south and weaker if the target industry was in the first stage of its life cycle. The reason for this impact could be that the start-up costs (such as land prices) are lower in less dense areas. Regional unemployment also had a negative impact on entry by domestic de-novo firms. Therefore, no support was found for the unemployment push effect. Areas with a high level of unemployment signalled a lack of buoyancy and therefore had a lower level of entry by this group of entrants.

Area specialization had a positive impact on entry, except when entry was into one of the regions of the south and an industry in the second stage of its life cycle. This means that if entry is occurring into a relatively old industry in one of the core regions of the south, a more diversified region is preferred.

Domestic incumbents were encouraged to enter industries with a higher profit, a higher capital intensity and a larger existence of small firms. The positive impact of capital intensity on entry was stronger if entry was into industries in the first stage of their life cycle or one of the core regions of the south. However, existence of small firms had a very weak positive impact if entry was into industries in the first stage of their life cycle. On the contrary, industry growth had a negative impact on entry by domestic incumbents if they were opening their new plants in one of the regions of the north. However, this impact was very weak if they were entering in one of the core regions of the south. Domestic incumbents were also deterred from entry into highly concentrated industries, although the effect was present only if entry was into one of the regions of the south. Room created due to previous exits had a positive impact on entry by domestic incumbents if they were entering into industries in the second stage of their life cycle, but a negative impact if they were entering into industries in the first stage of their life cycle. This group of entrants are neither deterred nor encouraged to enter industries characterised with a high scale disadvantage ratio.

At a regional level, high demand signalled higher profit opportunities and therefore encouraged their entry. On the contrary, specialization had a negative impact on entry by domestic incumbents. Therefore, this group of entrants preferred a more diversified region to a more specialised one. Unemployment also had a negative impact on their entry, although the effect was very weak if they were entering into industries in the first stage of their life cycle.

Population density of a region had a positive impact on entry by domestic incumbents if they were entering into industries in the first stage of their life cycle, but a negative impact if they were entering into industries in the second stage of their life cycle. This shows the importance of a large potential market in the success of firms operating in relatively young industries. However, in relatively old industries where their market had stabilised, the higher start-up costs in such areas offset the benefits from providing a larger market and this decreased their entry.

Industry growth had a positive impact on entry by *foreign firms*, while industry profit had no significant impact on their entry. Therefore, foreign entrants were more sophisticated decision makers, in that instead of taking past industry profit took past industry growth as a proxy for future profits. However, the effect of industry growth on entry by foreign firms was present only if entry was into one of the core regions of the south. Room created in the market, due to previous exits, also had a positive impact on their entry. Scale disadvantage ratio and capital density both had a positive impact on entry by this group of entrants, while the positive effect of capital density was stronger if they were entering into one of the core regions of the south. Concentration also had a positive impact on entry by foreign firms, although the effect was present only when entry occurred into industries in the first stage of their life cycle. Due to the advantages that foreign entrants possessed they were capable of overcoming entry barriers and therefore preferred industries characterised with a high scale disadvantage ratio and high capital intensity. For the same reason they were discouraged to enter industries with a large population of small firms.

Specialization in a region had a negative impact on entry by foreign firms, although the effect was present only if entry was into one of the core regions of the south. Unemployment also had a negative impact on entry by foreign firms.

Population density had a negative impact on entry by foreign firms if they were entering into industries in the first stage of their life cycle, but a positive impact if they were entering into industries in the second stage of their life cycle. Finally, regional demand had no significant impact on entry by foreign firms.

As it is evident from the above findings, the magnitude and the direction of the impact of a variable upon entry rates depend on the industry's stage in its life cycle and on the geographical location of the new plant. For example if one examines the elasticities reported for the representative case in Table 4.15, it is evident that variables that have the highest effect on entry by domestic de-novo firms are profits and ratio of small firms at the industry level and the degree of house ownership, density, ratio of small plants and unemployment at the regional level. On the other hand, entry by domestic incumbents was most responsive towards profits and the exit rate, at the industry level, and area specialization, density and unemployment, at the regional level. Finally, entry by foreign firms was mostly responsive towards exit rate and small firm ratio at the industry level and density and unemployment at the regional level.

Overall, the major findings from this chapter are as follows: 1) the characteristics of entrants are equally important in determining their choice of industry and region as the characteristics of the industries and regions. However, in this study it was not possible to further differentiate between entrants based on other characteristics[24]; 2) the stage in the industry's life cycle has a significant impact on entry as the type of entrants and their incentives can vary significantly across the two different stages of industry's life cycle; 3) the effect of certain industrial and geographical specific factors on entry were found to vary across the two different stages of the industry's life cycle; 4) in the context of the UK manufacturing industries, the fundamental differences between the southern and the northern regions of the UK significantly affected the type and incentive of entrants and 5) the differences between the southern and the northern regions of the UK not only affected entry directly but also changed the impact of certain geographical and industrial specific factors on entry.

Therefore, it can be concluded that the entry decision is complex, which is affected by various factors. Not only the heterogeneity between entrants has to be taken into account, but also the determinants of entry have to be carefully examined. Those models that only take account of the standard geographical and industrial specific factors have a deficiency in that they oversimplify the entry determinants. The stage in industry life cycle and the fundamental differences between the southern and the northern regions of the UK need also to be taken into account, if one wishes to study the entry decision in more detail. These factors not only affect entry directly, but also have an effect on entry through changing the impact of the geographical and the industrial specific factors on entry. Therefore, future research should perhaps take account of such influences and evaluate the entry decision in a more detailed context than before.

[24] The reason was explained in Footnote 3.

4.5 Appendix to Chapter 4

Measuring scale disadvantage ratio

Scale disadvantage ratio $_{it}$ = (*Minimum efficient scale* ÷ *Cost disadvantage ratio*) $_{it}$.

Minimum efficient scale $_{it}$ = (Mean output of the largest plants producing 50% of industries output ÷ total industry output) $_{it}$.

Cost disadvantage ratio $_{it}$ = (Average gross value added for the smallest plants producing 50% of industries output ÷ Average gross value added for the largest plants producing 50% of industries output) $_{it}$.

Measuring area specialization

$$Degree\ of\ specialization_j = \sum_{i=1}^{20} \left(\frac{e_{ij}}{e_j} \right)^2$$

Where e_{ij} is the output produced by industry i in region j and e_j is the total output produced in region j.

Table A4.16 Average plants age and the associated stage of the industry life cycle in the manufacturing sectors in 1995.

Description	1980 Standard industrial classification code	Average age of plants in 1995	Stage of the Industry life cycle
Metal manufacturing	22	26	2
Extraction of minerals not elsewhere specified	23	26	2
Manufacture of non-metallic mineral products	24	9	1
Chemical industry	25	14	1
Production of man-made fibres	26	26	2
Manufacture of metal goods not elsewhere specified	31	16	1
Mechanical engineering	32	14	1
Manufacture of office machinery and data processing equipment	33	9	1
Electrical and electronic engineering	34	6	1
Manufacture of motor vehicles and parts	35	26	2
Manufacture of other transport equipment	36	26	2
Instrument engineering	37	12	1
Food, drink and tobacco manufacture industries	41	20	2
Textile industry	43	26	2
Manufacture of leather and leather goods	44	18	2
Footwear and clothing industries	45	21	2
Timber and wooden furniture industries	46	11	1
Manufacture of paper and paper products; printing and publishing	47	19	2
Processing of rubber and plastics	48	15	1
Other manufacturing industries	49	9	1

Chapter 5: The Determinants of Exit

5.1 Introduction

According to Geroski (1995), "the growth and survival prospects of new firms will depend on their ability to learn about their environment, and to link changes in their strategy choices to the changing configuration of that environment…the more turbulent is the market environment, the more likely it is that firms will fail to cope. If the process of new entry continually throws up new aspirants for market places, then slow learning coupled with a turbulent environment means that high entry rates will be observed jointly with high failure rates" (p. 21). However, the ability of firms to adjust themselves to the turbulent environment depends on a combinations of different plant, industry, geographical, owner enterprise and time specific factors.

In this chapter, using a hazard model, the closure decision of plants that opened in the U.K. manufacturing sectors during the 1974-95 period will be analysed. Availability of the ARD[1], makes it possible to study these exit decisions at the most disaggregated level (plant level) and explore the effect of various plant, industry and owner-enterprise specific factors on this decision. In this regard, Section 5.2 reviews the literature regarding various factors that have been found to have an impact on the exit decision. Section 5.3.1 provides a review on the survival analysis and the non-parametric methods of estimating the hazard and the survivor functions. Section 5.3.2 provides a brief overview of the econometric model (time varying Cox model) that is going to be used. Section 5.3.3 explains the variables that are going to be used in the model, together with their definitions. Section 5.3.4.1 provides a preliminary analysis of the data by employing the Kaplan-Meier survival function for different categories of plants, based on different plant, owner-enterprise and industry specific factors that are

[1] Explained in Section 3.2.

explained in Section 5.3.3. Section 5.3.4.2 provides the results of estimating the time varying Cox model and interprets the results. Finally, Section 5.4 draws conclusions from the findings in this chapter.

5.2 Literature Review

5.2.1 Plant specific factors

Country of ownership: ownership status is expected to affect a plant's risk of closure. According to Caves (1996) foreign investments can be riskier than domestic investments due to two reasons[2]. McCloughan and Stone (1998) found that there was no significant impact of foreign ownership on plant closure in the northern regions of England. However, Colombo and Delmastro (2000) found that in the Italian metalwork industry foreign owned plants were more likely to be closed.

Change in ownership: change in ownership can happen either to a foreign enterprise or to a UK enterprise. Foreign firms have the choice of entering the host country either by building new plants (greenfield entry) or by acquiring the already existing plants (brownfield entry). These two different modes of entry by foreign enterprises can have different impacts on plants' risk of closure[3]. In the case of foreign acquisitions, there is always the problem of assimilating the new plants into the existing organization, which can significantly affect the performance and chance of closure of the acquired plants. In the case of acquisitions by UK enterprises there are also such problems, which can increase the risk of closure for the acquired plants. McGuckin and Nguyen (2001) found that change of ownership, as an endogenous variable, had a positive impact on the risk of closure of the smaller and the less productive plants.

[2] These reasons are explained in Page 43.

[3] These impacts and the associated reasons are explained in Pages 45-46.

Multi-unit versus single-unit plants: Reynolds (1988), Baden-Fuller (1989) and Ghemawat and Nalebuff (1990) showed that multi-plant firms are the first to reduce capacity and they do so by closing down their smallest or highest cost branch plants[4]. In terms of the empirical work in this area, Baden-Fuller (1989), Audretsch and Mahmood (1995), Mata *et al.* (1995) and Colombo and Delmastro (2000) found that single-unit plants had a higher likelihood of survival compared to that of multi-unit plants. Disney *et al.* (1999) found that this relationship was dependent on the age of plants and Dunne *et al.* (1989) found that it was dependent on the size of plants.

Start-up size, current size and age: in the models developed by Jovanovic (1982) and Ericson and Pakes (1995) it is shown how growth and age positively affects the likelihood of survival[5]. The positive impact of initial size, growth and age was found in various empirical studies e.g. those of Dunne *et al.* (1989), Audretsch (1994), Mata and Portugal (1994), Audretsch and Mahmood (1995), Boeri and Bellman (1995) and Doms *et al.* (1995).

Exit barriers: the major source of exit barriers, according to Caves and Porter (1976), are durable and specific assets (DSAs). Tangible fixed assets, as one of the sources for DSAs, create a major source for sunk costs[6]. Dixit (1989) showed that the sunk component of costs creates a barrier for both entry and exit of firms[7]. In terms of the empirical work in relation to the impact of sunk costs on exit, Audretsch (1994) and Doms *et al.* (1995) both found a negative impact of sunk costs on plant closure. Colombo and Demlastro (2000, 2001) found that investment decisions were more

[4] The associated reason is explained in Pages 47-48.
[5] The associated reasons are explained in Pages 49-50.
[6] DSAs are explained in Page 51.
[7] In this case, firms think longer before they commit resources and once they enter, they wait longer before they exit.

irreversible in older plants, while younger more capital intensive plants exhibited higher fixed (as opposed to sunk) costs and therefore had more flexibility to leave.

Profitability, productivity or efficiency of firms: the major reason for exit according to Hudson (1990) is when a firm's liquidity falls below zero. Studies by Doms *et al.* (1995), Oulton (2000) and Aw *et al.* (2001) used productivity as a proxy for profitability and found that plants that were closed had lower productivities than plants that remained open. Lieberman (1990) found that smaller plants exit first, due to their small size, which directly affects their efficiency[8].

5.2.2 Owner-enterprise specific factors

Size of the multi-plant firms: one of the important factors that can affect the risk of closure of multi-unit plants is the size of the controlling enterprise. Lieberman (1990) found that, *ceteris paribus*, a firm's capacity share of industry had a positive impact on the likelihood of closure of plants under its control. According to Lieberman, the reason is that, *ceteris paribus,* large firms cut capacity by a greater percentage than small firms.

5.2.3 Industry specific factors

Entry (the displacement effects): The causal relationship running from entry to exit can be due to two effects: a displacement effect and the effect of age and size on plant survival[9]. The following empirical studies all found a positive impact of (lagged) entry

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[8] However, it must be borne in mind that measures such as productivity or efficiency are not a good proxy for profitability. These measures are affected only by the supply side factors, which are firm specific, while profitability is affected by both the supply and the demand side factors. The reason is that Profits are calculated as $\pi=PY-Tc$, where π is the level of profits, P is the market prices, Y is the level of output and Tc is the total costs. However, P is affected by both the demand and the supply side factors and Y is affected by the supply side factors. Therefore, profits are affected by both the supply and the demand side factors.
[9] See Page 54.

on exit: Dunne *et al.* (1988), Mata and Portugal (1994), Baldwin (1995), Boeri and Bellman (1995) and Ilmakunnas and Topi (1999).

Growth: the possible impact of demand growth on exit is through its effect on plants' profitability[10]. In terms of the direct impact of growth on exit, Boeri and Bellman (1995) found no such significant impact. Mata *et al.* (1995) found that industries characterised with high growth and high entry had a higher rate of plant exit. On the contrary, Mata and Portugal (1994) found that in fast growing industries firms survived longer. Disney *et al.* (1999) found that the impact of growth on exit was positive but it declined with the age of plants.

5.3 Empirical work

5.3.1 Background to survival analysis

Survival analysis is concerned with the analysis of response data, which is the time until a particular event (called the endpoint) occurs. In this study, the event of interest is the time until a given plant closes down. A survival time t can be regarded as a non-negative variable and its probability distribution function can be specified by:

$$F(t) = Pr(t < T) \tag{1}$$

which is defined as the probability that the random variable t is less than some value T. The associated density function is $f(t) = dF(t) / dt$. However, in the context of survival analysis, the survivor function, $S(t)$, is of a particular relevance. $S(t)$ is defined as the probability that a plant's survival time is greater than or equal to T and can be written as:

$$S(t) = 1 - F(t) = \Pr(t \geq T) \tag{2}$$

[10]There are competing theories regarding the relationship between cyclical effects and industry profitability. These theories together with the empirical works are explained in Page 55.

and is related to the probability density function, $f(t)$, by:

$$S(t) = \Pr(t \geq T) = \int_T^{\infty} f(t)d(t) \tag{3}$$

The probability distribution function, the density function and the survival function are alternative ways of specifying the distribution of t. However, another function, which is of particular importance in the survival time analysis, is the hazard function, $h(t)$, which is defined as:

$$h(t) = f(t) / S(t) = (dF/dt) / S(t) = (-dS/dt) / S(t) = -d \ln S(t) / dt \tag{4}$$

$h(t)$ is the probability that a particular plant closes in the interval (T, $T+1$), given that it has survived up to time T. Therefore, it can be written as:

$$h(t) = \lim_{h \to \infty} \Pr(T \leq t < T + h | t \geq T) / h \tag{5}$$

Finally, the cumulative hazard function (integrated hazard function) is

$$H(t) = \int_0^T h(t)d(t) \tag{6}$$

which is related to the survival function as follows:

$$S(t) = \exp[-H(t)] \tag{7}$$

In the case of actual data the non-parametric maximum-likelihood estimate of the hazard function is calculated as:

$$\hat{h}(t) = \frac{d_j}{n_j} \tag{8}$$

where d_j is the number of plants that close during the jth interval and n_j is the total number of plants at the beginning of this interval. The survivor function is calculated as (Kaplan and Meier, 1958):

$$\hat{S}(t) = \prod_{j | t_j \leq t} \left(\frac{n_j - d_j}{n_j} \right) \tag{9}$$

and finally the Nelson-Aalen estimator of the cumulative hazard function (integrated hazard function) is defined as:

$$\hat{H}(t) = \sum_{j|t_j \leq t} \frac{d_j}{n_j} \tag{10}$$

5.3.2 Regression model for survival analysis (The Cox Model)

The Cox model was first introduced by Cox (1972) and is the most widely used model in survival analysis. Based on this model, hazard rate for individual i (in the current study, plant i) at time t is calculated as:

$$h(t) = h_0(t)\exp(\beta' x) \tag{11}$$

where x is a vector, containing the value of the covariates for plant i, β is the parameter vector to be estimated and $h_0(t)$ is the baseline hazard[11] at time t. The hazard ratio between any two individuals can be calculated as:

$$\frac{h_i(t)}{h_j(t)} = \exp(\beta'(x_i - x_j)) \tag{12}$$

It can be seen that the hazard ratio is independent of time, t, and, therefore, remains constant. This is the major property of the Cox model. This model is fitted by maximising the partial likelihood function, introduced by Cox (1972). This function is the product of various terms, one for each failure time. Each term is the conditional probability of an individual with covariate vector x_i, failing at time t, given that there is a failure at that time. This can be expressed as a product over the n failures

$$L = \prod_{t=1}^{n} \frac{\exp(\beta' x_i)}{\sum_{l \in R_i} \exp(\beta' x_l)} \tag{13}$$

[11] The baseline hazard is the value of hazard rate when all the covariates for the individual i are equal to zero.

where R_i is the set of all individuals still at risk at failure time t. However, the Cox model only accommodates those variables where their value is fixed for an individual. Altman and de Stavola (1994) gave some detail on how the Cox model can be extended to include time dependent covariates[12] of the form $x(t)$ in the model

$$h(t) = h_0(t)\exp(\beta' x(t)) \tag{14}$$

Altman and de Stavola referred to this model as the updated-covariates model, which is also known as the extended Cox model. Both fixed and time dependent covariates can be included in the extended Cox model. However, it will no longer be a proportional hazard model, as the time dependence of the covariates has destroyed the constancy of the hazard ratio. In the current study, equation (14) is applied, as there will be both constant and time variant covariates in the model. At the same time, no distribution is specified for the baseline hazard. This makes the model more flexible and allows the covariates to be estimated without assuming any particular parametric form for the hazard distribution[13].

5.3.3 Explanatory variables

In Section 5.2, the literature was reviewed, which related to the various factors that can have an impact on the likelihood of closure of plants. Table 5.1 presents the explanatory variables with their definitions that will be employed in this study.

In order to take into account of the country of ownership, plants are divided into five different categories. UK-owned plants are chosen as the base category and foreign-owned plants are divided into the following four categories: 1) those belonging to the

[12] A time dependent covariate is one that changes value either deterministically, such as age, or randomly, such as current employment of a plant.
[13] The most popular distributions assumed for the baseline hazard are the Weibull and the Exponential distributions. The probability density function for the Weibull distribution is $\alpha\lambda x^{\alpha-1}\exp(-\lambda x^{\alpha})$, where λ is the scale parameter and α is the shape parameter and both are greater than zero. The Exponential distribution is a special case of the Weibull distribution, where α is equal to one.

Table 5.1 Variable Definitions (and means and standard deviations)[a]

Variable	Definitions	Weighted Mean	Standard deviation
Plant Specific Factors			
US_{it}	Dummy coded 1 if plant *i* is US-owned at time *t*=1974, ...1995	0.054	0.225
EU_{it}	Dummy coded 1 if plant *i* is EU-owned at time *t*=1974, ...1995	0.039	0.193
SEA_{it}	Dummy coded 1 if plant *i* is SE Asian-owned at time *t*=1974, ...1995	0.005	0.069
O_FO_{it}	Dummy coded 1 if plant *i* is other foreign-owned at time *t*=1974, ...1995	0.017	0.127
$Greenfld_i$	Dummy coded 1 throughout if plant *i* was set-up by foreign-owned company	0.019	0.135
ΔFO_{it}^{74-79}	Dummy coded 1 when plant *i* is acquired by FO-sector in *t*=1974-1979 (remains 1 thereafter)	0.013	0.115
$\Delta \mathrm{FO}_{\mathrm{it}}^{80-89}$	Dummy coded 1 when plant *i* is acquired by FO-sector in *t*=1980-1989 (remains 1 thereafter)	0.018	0.132
$\Delta \mathrm{FO}_{\mathrm{it}}^{90-95}$	Dummy coded 1 when plant *i* is acquired by FO-sector in *t*=1990-1995 (remains 1 thereafter)	0.007	0.082
ΔOWN_{it}^{74-79}	Dummy coded 1 when plant *i* changes ownership within UK-owned sector or to UK-sector in *t*=1974-1979 (remains 1 thereafter)	0.061	0.239
ΔOWN_{it}^{80-89}	Dummy coded 1 when plant *i* changes ownership within UK-owned sector or to UK-sector in *t*=1980-1989 (remains 1 thereafter)	0.134	0.341
ΔOWN_{it}^{90-95}	Dummy coded 1 when plant *i* changes ownership within UK-owned sector or to UK-sector in *t*=1990-1995 (remains 1 thereafter)	0.053	0.224
$SINGLE_{it}$	Dummy coded 1 when plant *i* is a single plant in year *t*	0.222	0.415
$\ln START\_EMP_i$	Employment in plant *i* in start year	3.086	1.271
$\ln EMP_{it}$	Current employment in plant *i* in year *t*	3.256	1.422
AGE_{it}	Age of plant (*t* minus year opened +1) in years	6.336	5.107
$\ln REL\_P\_SZE_{it}^{b}$	Employment of plant *i* relative to enterprise *k* to which plant belongs in *t*	-3.065	2.678
$\ln CAP\_LAB_{it}$	Capital-to-labour ratio for plant *i* in time *t*	-5.962	2.257
$\ln T\_EFF_{it}$	Technical efficiency in plant *i* and time *t*	-0.402	0.459
IA_{it}	Dummy variable coded 1 if plant *i* is located in GB Intermediate or Development Area in *t*	0.406	0.491
$\mathrm{OPEN}_{\mathrm{it}}^{80-84}$	Dummy coded 1 if plant *i* opened in *t*=1980-1984	0.165	0.371
$\mathrm{OPEN}_{\mathrm{it}}^{85-89}$	Dummy coded 1 if plant *i* opened in *t*=1985-1989	0.193	0.395
$\mathrm{OPEN}_{\mathrm{it}}^{90-95}$	Dummy coded 1 if plant *i* opened in *t*=1990-1995	0.144	0.351
Owner-enterprise Specific Factors			
$\ln REL\_E\_SZE_{kt}^{b}$	Employment of enterprise *k* relative to industry employment in *t*	-1.703	2.340
Industry Specific factors			
$\ln DISPLACE_t^{c}$	Employment of new entrants ÷ employment of existing plants in time period *t*	-2.145	0.854
$\ln GROWTH_t^{c}$	Growth in industry real gross output, *t*-1 to *t*.	0.023	0.169

Source: ARD (Unless otherwise stated).

[a] In addition to the above variables, 200 industry dummy variables at the 4-digit level and 10 standard region dummy variables will also be included in the econometric model in Section 5.3.4.2.

[b] Single-plant enterprises are coded as zero.

[c] Calculated separately for each 4-digit industrial sector.

United States (US_{it}), 2) those belonging to the European Union countries (EU_{it}), 3) those belonging to the South East Asian countries (SEA_{it}) and 4) those belonging to the other foreign countries (O_FO_{it}). Foreign-owned plants are expected to have a higher likelihood of closure in comparison to the UK-owned plants (Caves, 1996; Colombo and Delmstro 2000). The variable $Greenfld_i$ captures the mode of entry by the foreign enterprise, which means whether it enters by setting up a new plant (greenfield entry) or acquiring an already existing plant from a UK enterprise (brownfield entry). Brownfield entry has been found in the studies by Hennart and Park (1993) and Buckley and Casson (1998) to have a positive impact on plant survival. The reason, proposed by the authors, was that brownfield entry is a less risky mode of entry. On the contrary, MacCloughan and Stone (1998) in their studies found the opposite to be true.

Change in ownership is divided into two major categories: 1) change from UK to foreign ownership and 2) change to or within a UK sector. These two major categories are each further divided into three sub-categories based on whether ownership change happened during the selected periods 1974-79, 1980-89 or 1990-95. Hence, the first group includes ΔFO_{it}^{74-79}, ΔFO_{it}^{80-89} and ΔFO_{it}^{90-95}, and the second group includes ΔOWN_{it}^{74-79}, ΔOWN_{it}^{80-89} and ΔOWN_{it}^{90-95}. The base category for each variable is the plants that did not change ownership in a given time period. In general, change in ownership is expected to have a positive impact on the likelihood of plant closure caused by the problems associated with assimilating of acquired plants into the new organization (McGuckin and Nguyen, 2001).

$SINGLE_{it}$ captures the effect of being a single-plant unit. The base category in this case is taken to be the plants owned by multi-plant firms. Plants belonging to multi-plant firms are assumed to be more likely to be closed than single-unit plants (Baden-Fuller 1989; Audretsch and Mahmood, 1995; Mata *et al.* 1995). The initial size of a plant, its current size and its age are denoted by the variables *ln* $START\_EMP_i$, *ln* EMP_{it} and AGE_{it}, respectively. The expected impact of these variables on plant survival is positive (Dunne *et al.* 1989; Audretsch, 1994). *ln* $REL\_P\_SZE_{it}$ measures the size of a multi-plant unit relative to the size of the owner enterprise. The expectation is that the larger the size of a multi-unit plant, the greater is the likelihood of its survival (Reynolds, 1988; Baden-fuller 1989).

The magnitude of sunk costs, which is mainly embodied in capital expenditure, is denoted by the variable *ln* $\mathrm{CAP\_LAB}_{it}$. The more capital-intensive plants are expected to have a lower likelihood of closure (Audretsch, 1994; Doms *et al.* 1995; Colombo and Demlastro, 2001). The variable *ln* $\mathrm{T\_EFF}_{it}$ is included in order to capture how the efficiency level of plants effects their chance of closure. It is calculated using the approach proposed by Battese and Coelli (1993, 1995) and a frontier translog production function. The expectation is that plants with a lower level of efficiency close first (Doms *et al.* 1995; Aw *et al.* 2001). In order to capture the effect of government grants on plant survival, the variable IA_{it} is included. As government grants are mainly targeted towards plants located in GB intermediate and development areas, the expectation is that plants located in these areas will have a higher likelihood of survival compared to other plants. The variables $OPEN_{it}^{80-84}$, $OPEN_{it}^{85-89}$ and $OPEN_{it}^{90-95}$ are included in the model, in order to capture the effect of the time when plants opened on their likelihood of survival. The base category in this case is the plants that opened during the 1974-79 period.

The variable *ln* $REL\_E\_SZE_{kt}$ measures the size of an owner enterprise relative to the total size of the industry. The expectation is that plants belonging to larger enterprises have higher likelihood of closure compared to plants belonging to smaller enterprises (Lieberman, 1990).

The variables *ln DISPLACE*$_t$ and *ln GROWTH*$_t$ are calculated at the industry level. *ln DISPLACE*$_t$ measures the extent to which new plants in each year, at the total manufacturing level, are displacing the already existing plants and, also, the extent to which new entrants are short-lived[14]. This variable is assumed to have a positive impact on plant closure (Shapiro and Khemani 1987; Dunne *et al.* 1988; Boeri and Bellman 1995). The effect of cyclical downturns and upturns is captured through the variable *ln GROWTH*$_t$. The associated impact on the likelihood of closure has not been clearly identified in the previous empirical work. Mata and Portugal (1994) found that plant closure was lower in the fast growing industries. However, Mata *et al.* (1995) identified the opposite effect. The only two variables in Table 5.1 that are time invariant are *Greenfld*$_i$ and *ln START_EMP*$_i$, while the rest of the variables are time variant.

5.3.4 Results

5.3.4.1 Non-parametric estimates of the hazard and the survivor functions

Based on the weighted selected file in the ARD[15], 68601 plants entered the U.K. manufacturing sectors during the 1974-95 period. The associated survival time of these plants is ordered from the lowest to the highest as $t_1 < t_2 < \ldots < t_j$, where t_1 is equal to 1 year and t_j is equal to 22 years. The total failures observed during this period were 36237 and the remaining 32364 plants were right censored[16]. Treating all entrants as a homogeneous group of plants[17], and using the weighted selected file, the non-parametric hazard and survivor rates are calculated (see Table 5.2). Note that weights have been

[14] This is a natural consequence of our model specification. In this study, hazard rate is calculated based on the number of plants that are in the last year of their existence. The displacement effect is calculated based on the number of entrants in the same period. However, some new entrants age only one year and therefore the larger their number the higher will be the hazard rate in that year.

[15] Explained in Section 3.2.

[16] See the Appendix to this chapter.

[17] Heterogeneity will be introduced by differentiating between entrants based on a variety of plant, owner-enterprise and industry specific factors.

Table 5.2 The nonparametric hazard and survivor estimates for plants that opened in UK manufacturing industries during the 1974-95 period

Time t_j	Number of plants at the beginning of the interval n_j (1)	Closures during the interval d_j (2)	Number of plants open at the end of the interval $(n_j - d_j)$ (3)	Hazard rates $\hat{h}(t_j)$ (4)	Survivor rates $\hat{S}(t_j)$ (5)	Cumulative hazard rates $\hat{H}(t_j)$ (6)
1	68601	11000	57601	0.160	0.84	0.160
2	45346	6492	38854	0.143	0.72	0.304
3	30686	3788	26898	0.123	0.63	0.427
4	25415	3136	22279	0.123	0.55	0.550
5	20997	2359	18638	0.112	0.49	0.663
6	18125	1914	16211	0.106	0.44	0.768
7	14603	1545	13058	0.106	0.39	0.874
8	12179	1176	11003	0.097	0.35	0.971
9	10320	987	9333	0.096	0.32	1.066
10	8621	762	7859	0.088	0.29	1.155
11	7068	629	6439	0.089	0.27	1.244
12	5499	502	4997	0.091	0.24	1.335
13	4431	346	4085	0.078	0.22	1.413
14	3894	307	3586	0.079	0.21	1.492
15	3387	301	3086	0.089	0.19	1.581
16	2912	235	2677	0.081	0.17	1.661
17	2326	215	2111	0.092	0.16	1.754
18	1811	152	1659	0.084	0.14	1.838
19	1455	142	1312	0.098	0.13	1.935
20	1060	112	947	0.106	0.12	2.041
21	725	58	667	0.080	0.11	2.121
22	396	79	317	0.200	0.08	2.321

used in order to make these plants representative of the entire population of plants that opened during the 1974-95 period in the U.K. manufacturing sectors. In Table 5.2, column (1) shows the number of plants that were under observation at the beginning of each interval and column (2) shows the number of plants that closed during that interval. Column (3) is calculated by deducting column (2) from column (1). Hazard rates[18] in column (4) are calculated using equation (8). The survivor rates in column (5) are calculated using equation (9). Finally, the cumulative hazard rates in column (6) are calculated using equation (10). The estimated $h\ (t_j)$, $S\ (t_j)$ and $H\ (t_j)$ are plotted against time, t_j, in Figures 5.1, 5.2 and 5.3. $\hat{S}(t_j)$ and $\hat{H}(t_j)$ are known as the Kaplan-Meier estimate of the survival function and the Nelson-Aalen estimate of the cumulative hazard function, respectively.

Interpreting an empirical hazard function is rather difficult, as it usually does not have a smooth pattern. Figure 5.1 shows that hazard rates are decreasing over time (except for 1995, when it increased from 8% to 20%). The plots of the hazard rates are smoothed by calculating the cumulative (integrated) hazard function (Figure 5.2). The concave integrated hazard implies a decreasing hazard or a negative duration dependence (Kiefer, 1988)[19]. Figure 5.3 shows the Kaplan-Meier estimate of the survivor function. Starting from a high of 100% in the first year, survivor rates decrease to 8% at the end of the 22nd year. Based on the estimated survival rates, almost half (49%) of the plants that entered the U.K. manufacturing sector during the 1974-95 period were closed before their 6th year[20].

[18] Note that the hazard rates calculated in this section differ from those in Chapter 3. In this Section, entrants are not differentiated by the year they opened, while in Chapter 3 the hazard rates were averaged across entrants in different years.
[19] The integrated hazard for the exponential distribution is a straight line. A convex integrated hazard shows that hazard rate is increasing (a positive duration dependence), while a concave integrated hazard shows that hazard rate is decreasing (a negative duration dependence).
[20] In Section 3.3.4, it was found that almost half (47.3%) of the plants that opened during the 1974-96 period exited before the 5th year. The reason for this difference is the high first year exit rate of plants that opened in 1996 (41.4%).

Figure 5.1 Hazard rates of closure

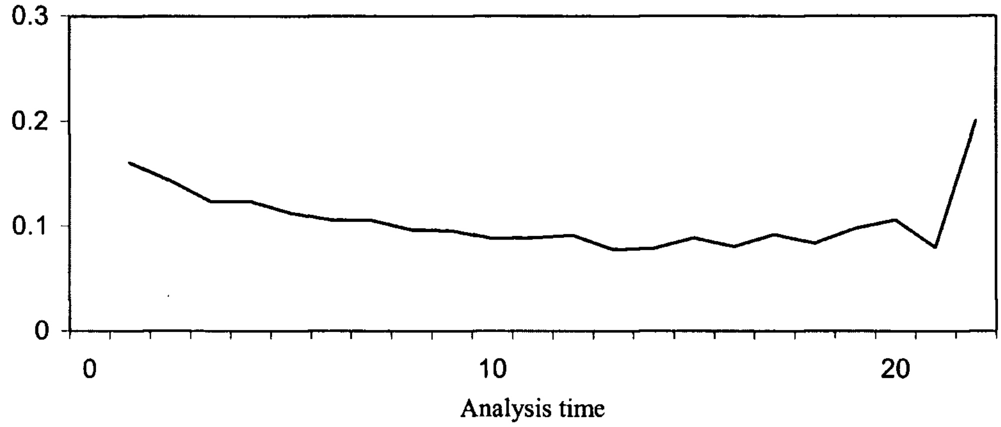


Figure 5.2 Nelson-Aalen estimates of the cumulative hazard function

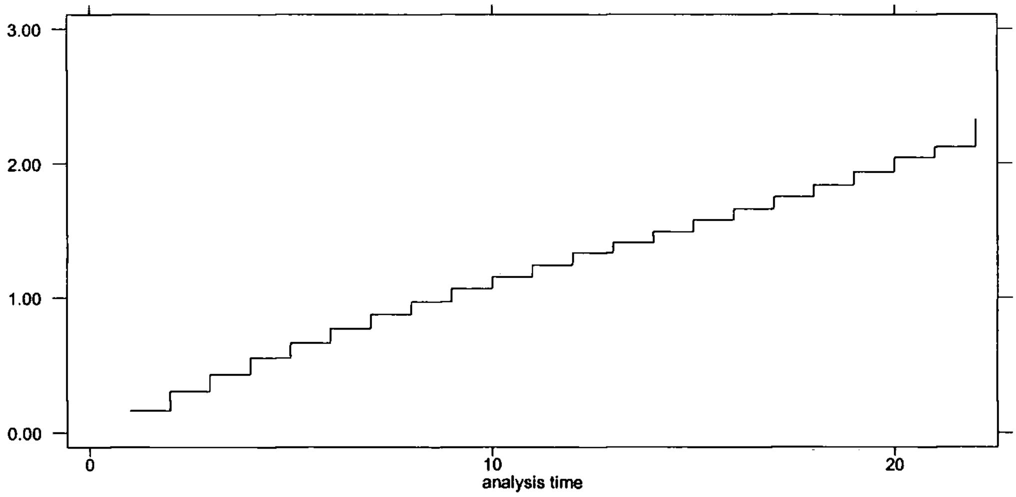
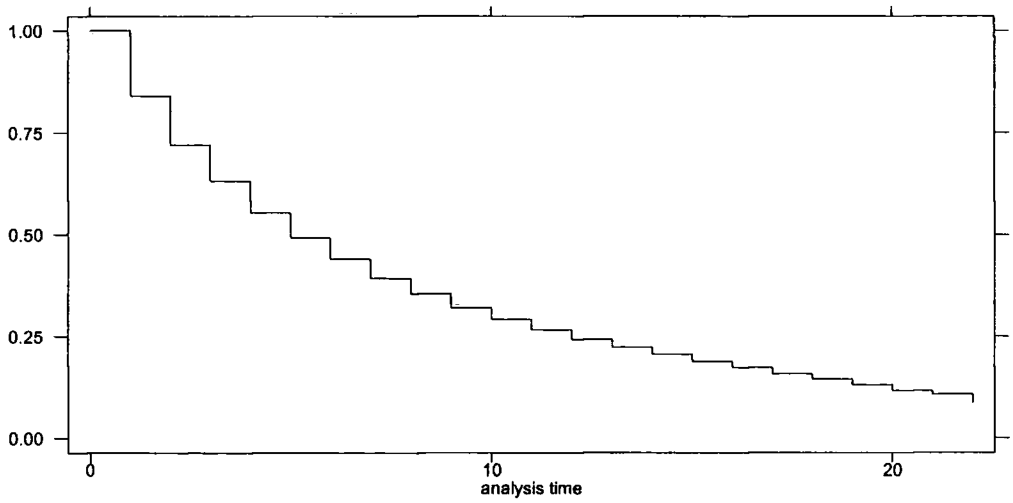


Figure 5.3 Kaplan-Meier estimates of the survivor function



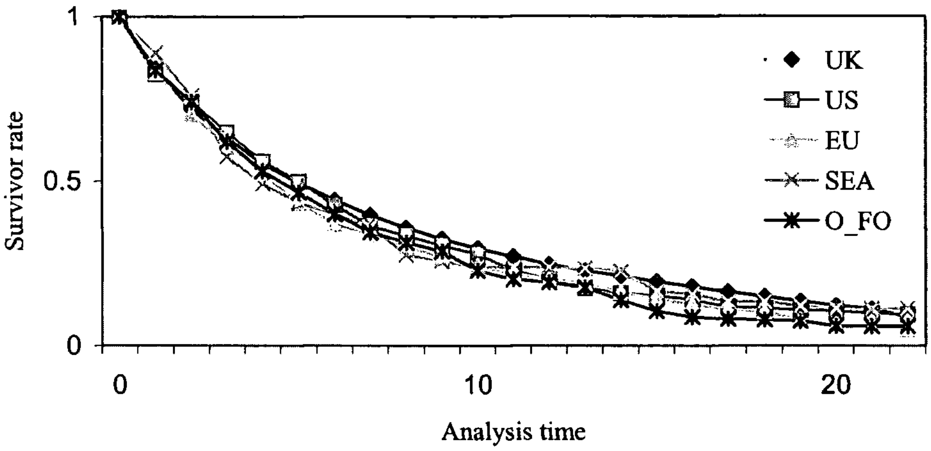
The above estimates were based on the assumption that entrants were a homogenous group of plants. However, as was discussed in Section 5.2, various plant, owner-enterprise and industry specific factors can significantly affect a plant's risk of closure (these variables were discussed in Section 5.3.3). Therefore, it is interesting to compare the survival rate of plants, in each year following entry, based on their characteristics.

Starting with the ownership factor, survivor rates are calculated for plants that opened during the 1974-95 period, denoted by their country of ownership (Table 5.3). Foreign-owned plants are divided into US-owned plants, US_{it}, EU-owned plants, EU_{it}, SEA-owned plants, SEA_{it}, and other foreign owned plants, O_FO_{it}. The survivor rate of these plants is compared with the survivor rate of UK-owned plants. These survivor rates are plotted against time, t_j, in Figure 5.4.

Table 5.3 Survivor rates, by country of ownership

Time t_j	UK_{it}, $\hat{S}(t_j)$ (1)	US_{it}, $\hat{S}(t_j)$ (2)	EU_{it}, $\hat{S}(t_j)$ (3)	SEA_{it}, $\hat{S}(t_j)$ (4)	O_FO_{it}, $\hat{S}(t_j)$ (5)
1	0.8406	0.8239	0.8302	0.8893	0.8358
2	0.7183	0.7404	0.7030	0.7581	0.7399
3	0.6309	0.6483	0.6049	0.5742	0.6198
4	0.5540	0.5611	0.5238	0.4920	0.5307
5	0.4932	0.4986	0.4337	0.4342	0.4651
6	0.4432	0.4284	0.3706	0.3994	0.4012
7	0.3974	0.3646	0.3383	0.3611	0.3456
8	0.3590	0.3347	0.3029	0.2767	0.3142
9	0.3247	0.3049	0.2668	0.2563	0.2880
10	0.2967	0.2792	0.2442	0.2389	0.2282
11	0.2723	0.2295	0.2208	0.2389	0.2023
12	0.2475	0.2021	0.2027	0.2389	0.1926
13	0.2288	0.1761	0.1890	0.2353	0.1769
14	0.2126	0.1604	0.1641	0.2265	0.1388
15	0.1951	0.1524	0.1409	0.1655	0.1050
16	0.1801	0.1397	0.1255	0.1576	0.0867
17	0.1645	0.1190	0.1090	0.1345	0.0805
18	0.1499	0.1138	0.1031	0.1345	0.0787
19	0.1362	0.1085	0.0777	0.1214	0.0746
20	0.1221	0.1058	0.0630	0.1123	0.0593
21	0.1123	0.0996	0.0555	0.1123	0.0593
22	0.0879	0.0957	0.0489	0.1123	0.0593

Figure 5.4 Kaplan-Meier survivor estimates, by country of ownership



There is no clear difference between the survivor rates in Table 5.3 and Figure 5.4. In order to find out whether there is any significant difference, a Cox test was performed. This test is based on the difference between the expected and the actual number of failures in each category. It has a χ^2 distribution with the degree of freedom equal to four (number of categories - 1). The χ^2 value is significant at the 0.01 level (Table 5.4). Therefore, the null hypothesis that there is no significant difference in the survival rates can be rejected. However, this test is an overall test and does not indicate which two groups have significantly different survivor rates[21].

Table 5.4 Cox regression based test for equality of survivor curves, by country of ownership

	Events observed	Events expected	Relative hazard
UK_{it}	32273	32607	0.99
US_{it}	1941	1859	1.04
EU_{it}	1473	1299	1.13
SEA_{it}	140	141	0.99
O_FO_{it}	664	585	1.14
Total	36491	36491	1

Wald χ^2 (4) = 15.50; Pr> χ^2 = 0.0038

Next, we differentiate between foreign owned plants that have been set up by a foreign company (greenfield entrants) and all other plants. The survivor rate for these

[21] The STATA package used for estimation does not allow for a detailed test when data is population weighted.

two categories of entrants is calculated in Table A5.23 in the Appendix to this chapter[22]. Except for the second year, greenfield entrants have a lower survivor rate compared with that of other plants. The significance of this effect is tested in Table 5.5. Based on the value of the χ^2 test, the null hypothesis that there is no significant difference between these two groups in terms of their survivor rates can be rejected at 5% level of significance. The degree of freedom in this case is equal to 1, as there are only two categories.

Figure 5.5 Kaplan-Meier survival estimates, by greenfield entry

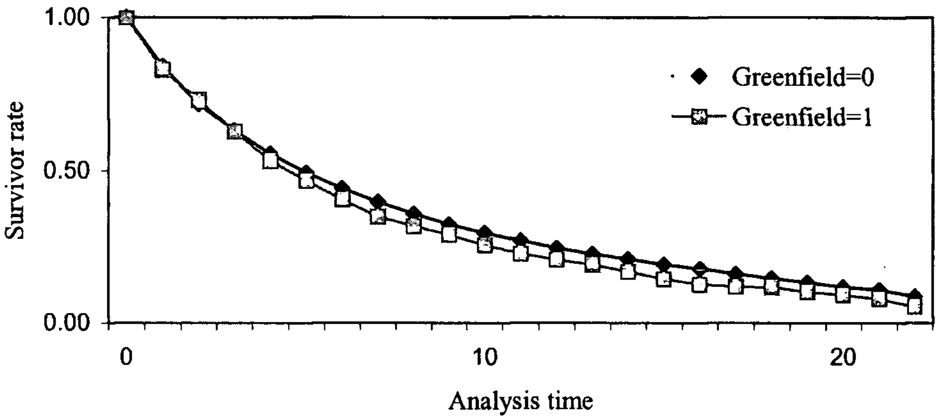


Table 5.5 Cox regression based test for equality of survivor curves, by greenfield entry

	Events observed	Events expected	Relative hazard
$Greenfld_i$ =0	32622	32846	0.99
$Greenfld_i$ =1	3508	3284	1.07
Total	36491	36491	1

Wald χ^2 (1) = 5.78; Pr> χ^2 = 0.0162

The effect of change to foreign ownership, on the survivor rate of the acquired plants, differs according to whether ownership change happened during the 1974-79, 1980-89 or 1990-95 period. Change into foreign ownership during the 1974-79 period, did not have any significant impact on the post acquisition survivor rate of plants. This is

[22] From this point on, only the diagrams are reported in the main body of the text, with associated tables presented in the Appendix.

apparent from the p value associated with the value of χ^2 distribution in Table 5.6 (the degree of freedom in this case is equal to one). On the other hand, change into foreign ownership during the 1980-89 period significantly affected the survivor rate for the acquired plants post acquisition. This category of plants had a higher survivor rate up to the fifth year post-acquisition, but after the fifth year they began to have a lower survivor rate. Therefore, this relationship is dependent on the age of plants post-acquisition. However, the Cox test shows that overall the survivor rate of plants, that changed ownership during the 1980-89 period, declined post-acquisition relative to those that did not change ownership (Table 5.7). In this case, the χ^2 test is significant at 1% level.

Figure 5.6 Kaplan-Meier survival estimates, by change to foreign ownership during the 1974-79 period

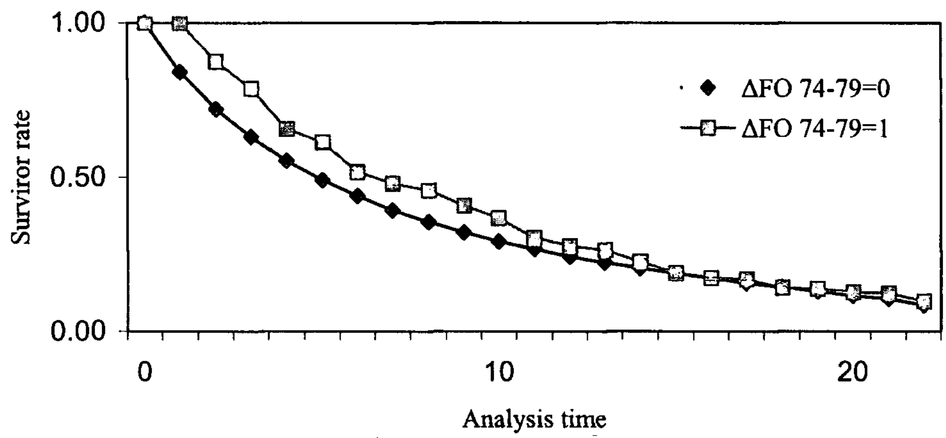


Table 5.6 Cox regression based test for equality of survivor curves, by change to foreign ownership during the 1974-79 period

	Events observed	Events expected	Relative hazard
ΔFO 74-79 =0	36198	36206	0.9998
ΔFO 74-79 =1	294	286	1.0282
Total	36491	36491	1

Wald χ^2 (1) = 0.13; Pr> χ^2 = 0.7158

Figure 5.7 Kaplan-Meier survival estimates, by change to foreign ownership during the 1980-89 period

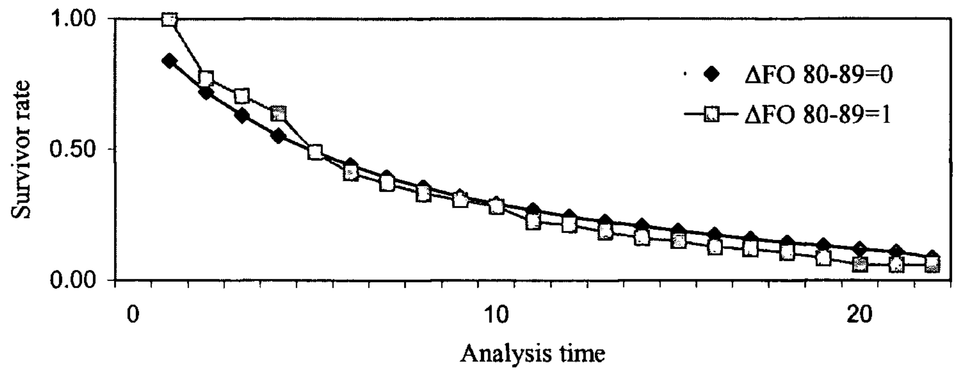


Table 5.7 Cox regression based test for equality of survivor curves, by change to foreign ownership during the 1980-89 period

	Events observed	Events expected	Relative hazard
ΔFO 80-89 =0	35957	36067	0.9972
ΔFO 80-89 =1	534	424	1.2652
Total	36491	36491	1

Wald χ^2 (1) = 12.88; Pr> χ^2 = 0.0003

Plants that changed ownership during the 1990-95 period, had a higher survivor rate during the first two years post acquisition. However, their survivor rate dropped afterwards and remained lower than those that did not change ownership during this period. In this case, the χ^2 test is significant at 0.0001 level. Therefore, we can reject the null hypothesis that there is no significant difference between the two survivor curves (Table 5.8).

Figure 5.8 Kaplan-Meier survival estimates, by change to foreign ownership during the 1990-95 period

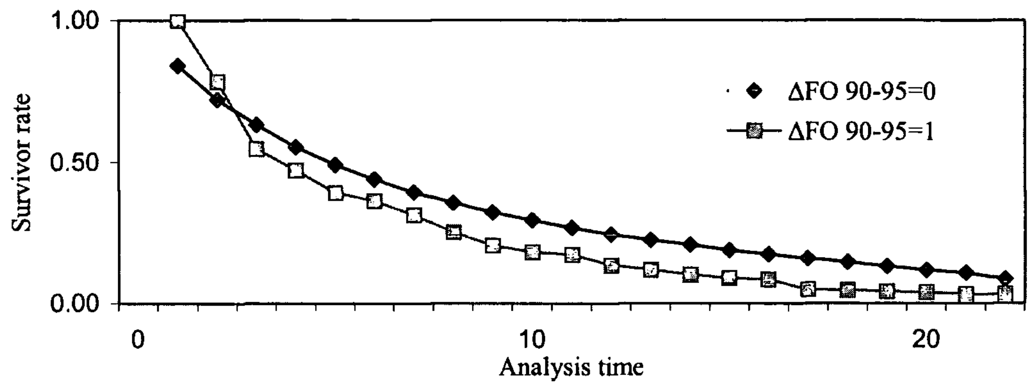


Table 5.8 Cox regression based test for equality of survivor curves, by change to foreign ownership during the 1990-95 period

	Events observed	Events expected	Relative hazard
ΔFO *90-95* =0	36229	36321	0.9980
ΔFO *90-95* =1	263	171	1.5437
Total	36491	36491	1

Wald χ^2 (1) = 28.69; Pr> χ^2 = 0.0000

Change to or within a UK sector had a more significant impact on the survivor rate of the acquired plants in different time periods, compared to change into foreign ownership during the same period. Change of ownership during the 1974-79 period significantly decreased the survivor rate of the acquired plants post-acquisition. The *p* value associated with the χ^2 test in this case is highly significant (see Table 5.9). Therefore, one can reject the null hypothesis that there is no significant difference between the two survivor curves. Plants that changed ownership during the 1980-89 period had a higher survivor rate compared to those that did not change ownership until the 8^{th} year post-acquisition. However, this relationship was reversed after the 8^{th} year. In this case, the relationship is based on the age of plants post-acquisition. The Cox test in Table 5.10 shows that the survivor rate of these plants is significantly lower than all other plants (the χ^2 test is significant even at 1% level).

Figure 5.9 Kaplan-Meier survivor estimate, by change to or within UK owned sector during the 1974-79 period

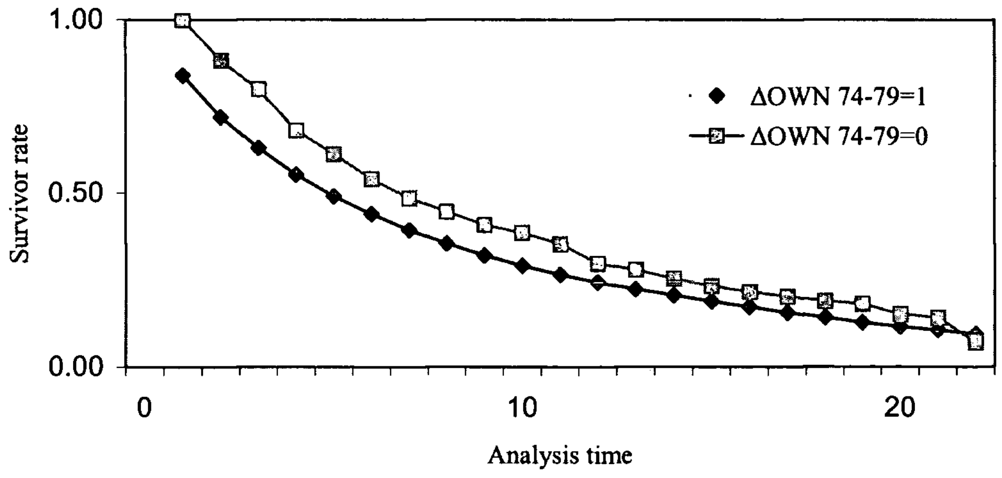


Table 5.9 Cox regression based test for equality of survivor curves, by change to or within UK owned sector during the 1974-79 period

	Events observed	Events expected	Relative hazard
ΔOWN 74-79 =0	1319	1353	0.9743
ΔOWN 74-79 =*1*	35172	35139	1.001
Total	36491	36491	1

Wald χ^2 (1) = 48; Pr> χ^2 =0.0000

Figure 5.10 Kaplan-Meier survivor estimate, by change to or within UK owned sector during the 1980-89 period

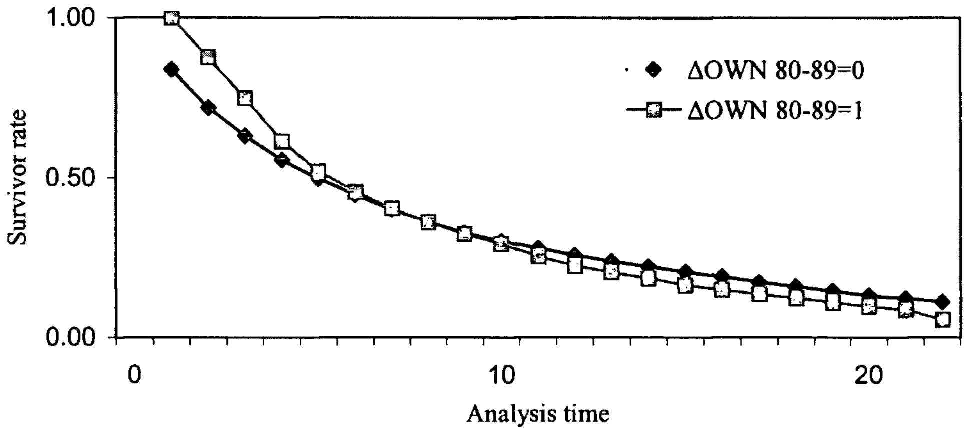


Table 5.10 Cox regression based test for equality of survivor curves, by change to or within UK owned sector during the 1980-89 period

	Events observed	Events expected	Relative hazard
ΔOWN 80-89 =0	32706	33336	0.9799
ΔOWN 80-89 =1	3785	3156	1.2386
Total	36491	36491	1

Wald χ^2 (1) = 63.33; Pr> χ^2 =0.000

Change to or within a UK sector during the 1990-95 period significantly decreased the survivor rate of the acquired plants post-acquisition, compared to those that did not change ownership during this period. The χ^2 test in this case is significant even at 1% level (Table 5.11). The survivor rates for the change of ownership are reported in Tables A5.24, A5.25, A5.26, A5.27, A5.28 and A5.29 in the Appendix to this chapter.

Figure 5.11 Kaplan-Meier survivor estimate, by change to or within UK owned sector during the 1990-95 period

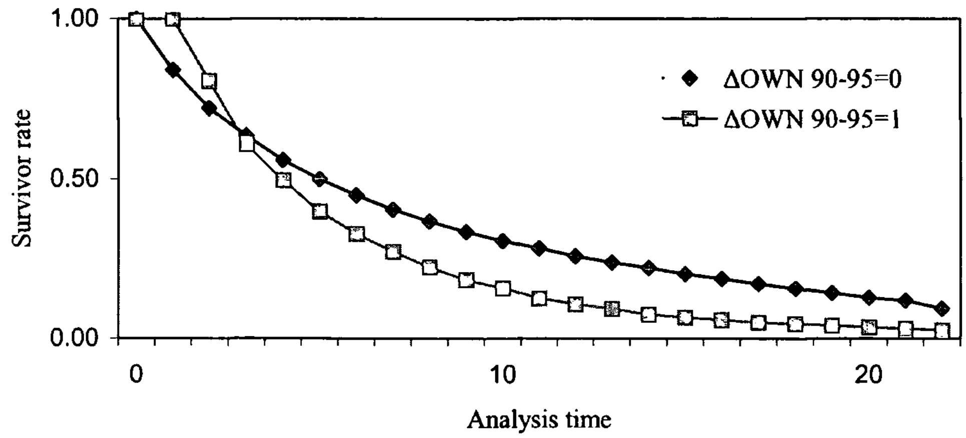


Table 5.11 Cox regression based test for equality of survivor curves, by change to or within UK owned sector during the 1990-95 period

	Events observed	Events expected	Relative hazard
ΔOWN 90-95 =0	33986	34953	0.9776
ΔOWN 90-95 =1	2505	1538	1.6716
Total	36491	36491	1

Wald χ^2 (1) = 341.51; Pr> χ^2 =0.000

Comparing the survivor rate of single plants with those belonging to multi-plant organizations, it was found that not only single plants had significantly higher survivor rates, but, also, the difference increased, as the plants got older. During the first year, 17% of plant belonging to multi plant organizations closed down. However, the percentage of single plants that closed down was only 13%. By the 22nd year, the percentage of single plants that survived was 37%, while the percentage of multi-unit plants that survived was only 6% (see Table A5.30 in Appendix to this chapter). The Cox test in Table 5.12 shows that single plants had significantly a higher survivor rate compared to plants belonging to multi-plant organizations.

Figure 5.12 Kaplan-Meier survivor estimate, by state of being a single unit plant

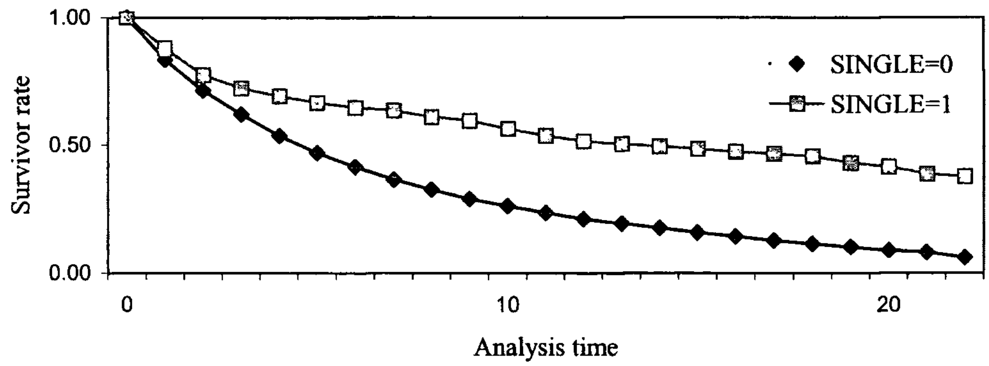


Table 5.12 Cox regression based test for equality of survivor curves, by state of being a single unit plant.

	Events observed	Events expected	Relative hazard
SINGLE =0	33788	31617	1.092
SINGLE =1	2703	4874	0.5651
Total	36491	36491	1

Wald χ^2 (1) = 253.48; Pr> χ^2 =0.000

In order to compare the survivor rate of plants with different initial employment size, the plants were divided into 6 different groups, based on the size of their initial employment. The survivor rate of these plants in years following their entry is shown in Table A5.31 in Appendix to this chapter and plotted against analysis time (age) in Figure 5.13. It is clear that plants with a larger initial size have a higher survivor rate. Plants with initial employment between 1 and 2 employees had 22% failure rate in the first year, while plants with initial employment greater than 500 had only 15% failure rate. This difference increases as plants age to the extent that 22 years after entry, survivor rate of plants with initial employment between 1 and 2 is only 4%, while survivor rate of plants with initial employment greater than 500 employees is 25%. The χ^2 test is highly significant (Table 5.13) showing that there are significant differences between the survivor rates of plants with different initial sizes[23].

[23]As it was mentioned previously, a detailed test of which two groups which have significantly different survivor rates is not possible in STATA, when data is population weighted.

Figure 5.13 Kaplan-Meier Survivor estimate, by initial employment size

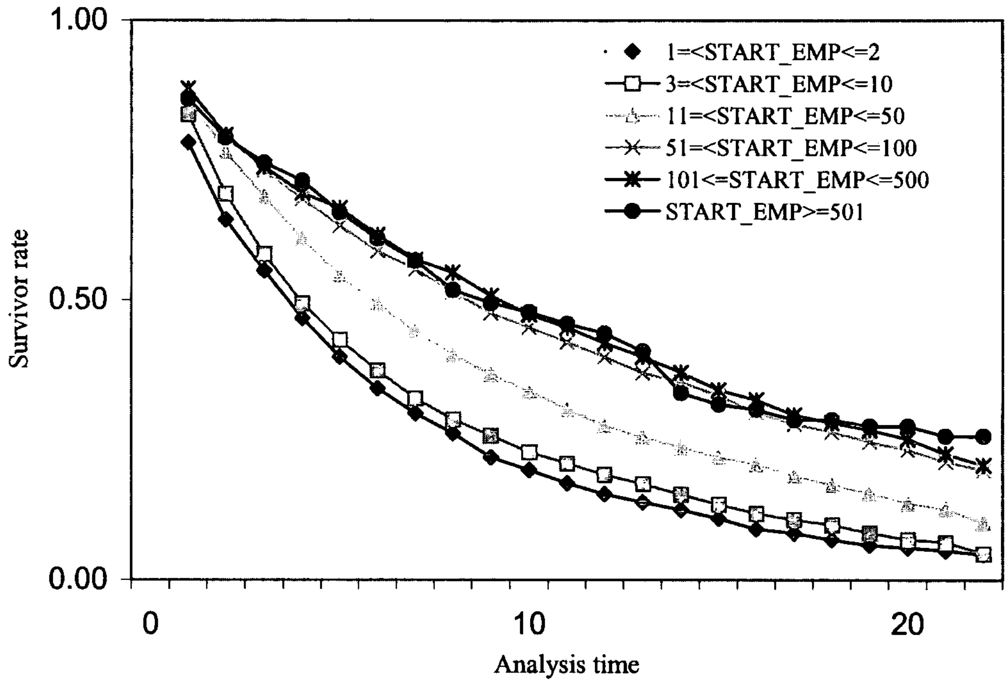


Table 5.13 Cox regression based test for equality of survivor curves, by initial employment size

	Events observed	Events expected	Relative hazard
1=< $START\_EMP_{it}$=< 2	5081	3822	1.3717
3=< $START\_EMP_{it}$ =< 10	14688	12768	1.1811
11=< $START\_EMP_{it}$=<50	14321	16261	0.8933
51=<$START\_EMP_{it}$=<100	1515	2230	0.6832
101=< $START\_EMP_{it}$=<500	745	1163	0.6436
$START\_EMP_{it}$>=501	142	247	0.5794
Total	36491	36491	1

Wald χ^2 (5) = 944.12; Pr> χ^2 =0.0000

The impact of current employment on the survivor rate of plants is very similar to that of initial employment. In this case, plants are again categorised into 6 different groups, based on the value of their current employment. The survivor rate for these different groups of plants is reported in Table A5.32, in the Appendix to this chapter, and plotted against age in Figure 5.14. Compared to the initial size, current size of plants has a more significant impact on the survivor rate of plants. Plants with current employment between 1 and 2 employees had 23% failure rate in the first year, while plants with current employment greater than 500 had only 14% failure rate. This difference increased as plants aged to the extent that 22 years after entry, survivor rate of plants with employment between 1 and 2 was only 4%, while survivor rate of plants with

Figure 5.14 Kaplan-Meier survival estimates, by current employment

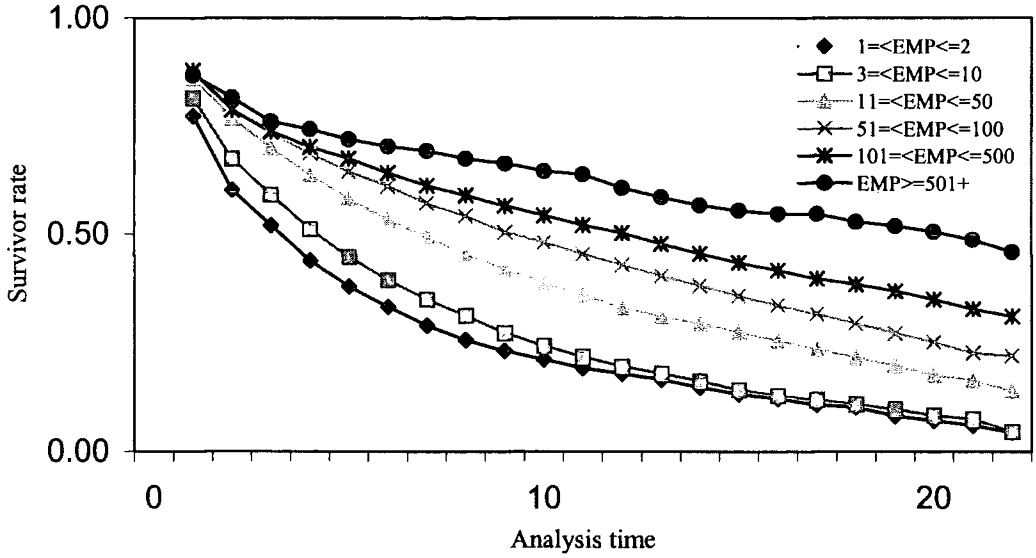


Table 5.14 Cox regression based test for equality of survivor curves, by current employment of the plants

	Events observed	Events expected	Relative hazard
$1<=EMP_{it}=<2$	5863	4160	1.4519
$3<=EMP_{it}=<10$	14679	12701	1.1918
$11<=EMP_{it}=<50$	13300	15409	0.8820
$51<=EMP_{it}=<100$	1675	2446	0.6932
$101<=EMP_{it}=<500$	918	1635	0.5641
$EMP_{it}>=501$	55	141	0.3990
Total	36491	36491	1

Wald χ^2 (1) = 1076.64; Pr> χ^2 = 0.0000

employment greater than 500 employees was 45%. The value of the χ^2 test shows that the differences between the survival rates of plants with different employment sizes are highly significant (see Table 5.14).

In order to find out whether size of the multi-unit plants affects their survivor rate, we divide these plants into two categories: 1) plants that their size, relative to the size of the owner enterprise, is greater than 0.5 and 2) plants that their size, relative to the size of the owner enterprise, is less than 0.5. From Table A5.33 in the Appendix and Figure 5.15 below it is clear that smaller multi-unit plants have a higher survival rate until the age of 4. However, the relationship reverses afterwards and these plants begin to have a lower survivor rates compared to their larger counterparts. Overall, the value of the χ^2 test shows that the survivor rate of the smaller multi-unit plants is only marginally lower than the survival rate of their larger counterparts (see Table 5.15).

Figure 5.15 Kaplan-Meier survivor estimate, by relative size of the multi-unit plant

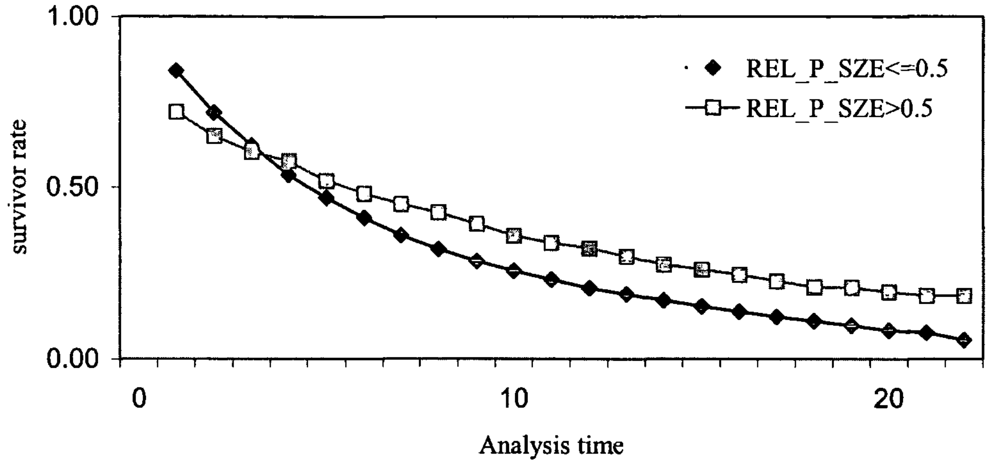


Table 5.15 Cox regression based test for equality of survivor curves, by relative size of the multi-unit plant

	Events observed	Events expected	Relative hazard
REL_P_SZE<=0.5	32076	31961	1.0037
REL_P_SZE>0.5	1713	1828	0.937
Total	33788	33788	1

Wald χ^2 (1) = 3.02; Pr> χ^2 =0.0824

In order to find out about the impact of capital intensity on the survivor rate of plants, the plants are divided into two categories based on the value of their capital to labour ratio: 1) plants with capital to labour ratio greater than 0.003 and 2) plants with capital to labour ratio less than 0.003[24]. The survivor rates are calculated in Table A5.34, in the appendix to this chapter, and plotted against age in Figure 5.16. It is evident that the less capital-intensive plants have a higher survivor rates compared to the more capital-intensive plants. The value of the χ^2 test is highly significant and, therefore, one can reject the null hypothesis that there is no significant difference between the two survival curves (see Table 5.16).

[24] 0.003 is the median capital to labour ratio.

Figure 5.16 Kaplan-Meier survivor estimate, by the degree of capital intensity

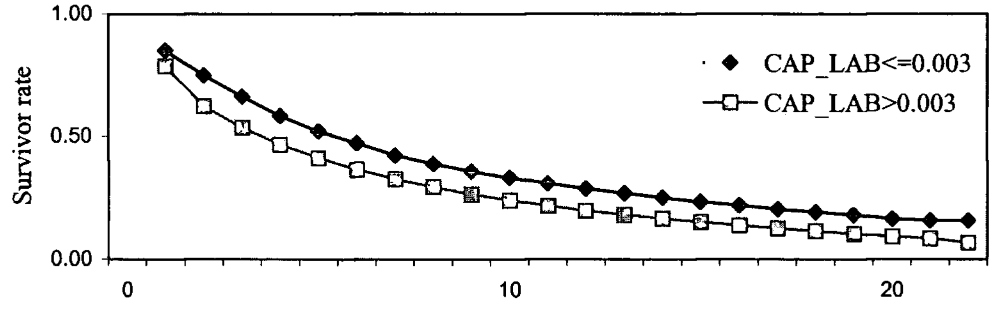


Table 5.16 Cox regression based test for equality of survivor curves, by the degree of capital intensity

	Events observed	Events expected	Relative hazard
CAP_LAB<=0.003	19867	21840	0.8911
CAP_LAB>0.003	16625	14652	1.1876
Total	36491	36491	1

Wald χ^2 (1) =191.75; Pr> χ^2 =0.0000

The effect of technical efficiency on the survivor rate of plants is examined by dividing the plants into two categories and comparing their survivor rates. Except for the first two years after opening, more technically efficient plants have a higher survival rate in comparison to the less technically efficient plants (see Table A5.35 in the appendix to this chapter and Figure 5.17). The value of the χ^2 test is significant at 5% level and, therefore, we can reject the null hypothesis that there is no significant difference between the two survivor curves (see Table 5.17).

Figure 5.17 Kaplan-Meier survivor estimates, by the magnitude of technical efficiency

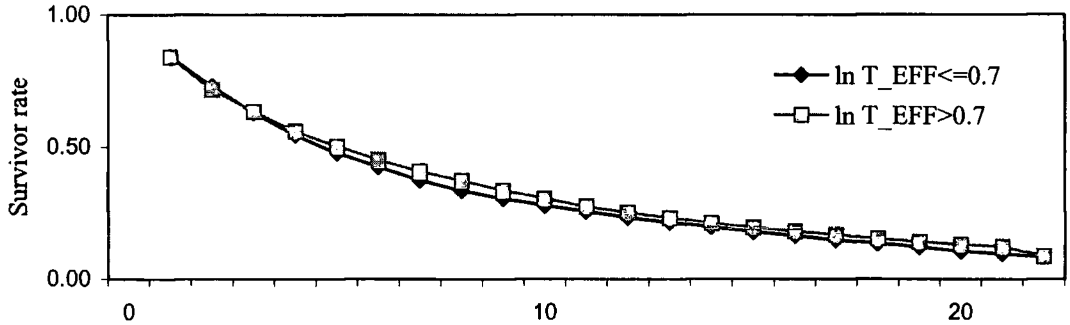


Table 5.17 Cox regression based test for equality of survivor curves, by technical efficiency

	Events observed	Events expected	Relative hazard
ln T_EFF<=0.7	14105	13735	1.0278
ln T_EFF>0.7	22386	22756	0.9836
Total	36491	36491	1

Wald χ^2 (1) =5.1; Pr> χ^2 =0.0239

In order to examine the impact of the size of a multi-plant organization on the survivor rate of plants belonging to it, we divide these plants into two categories, based on the size of their owner enterprise (size of the enterprise is calculated relative to total size of the industry). The survivor rates are calculated in Table A5.36 and plotted against age in Figure 5.18. The value of the χ^2 test in Table 5.18 shows that these differences are significant and, overall, plants belonging to larger enterprises have significantly lower survivor rates compared to plants belonging to smaller enterprises.

Figure 5.18 Kaplan-Meier survivor estimate, by relative size of the multi-plant enterprise

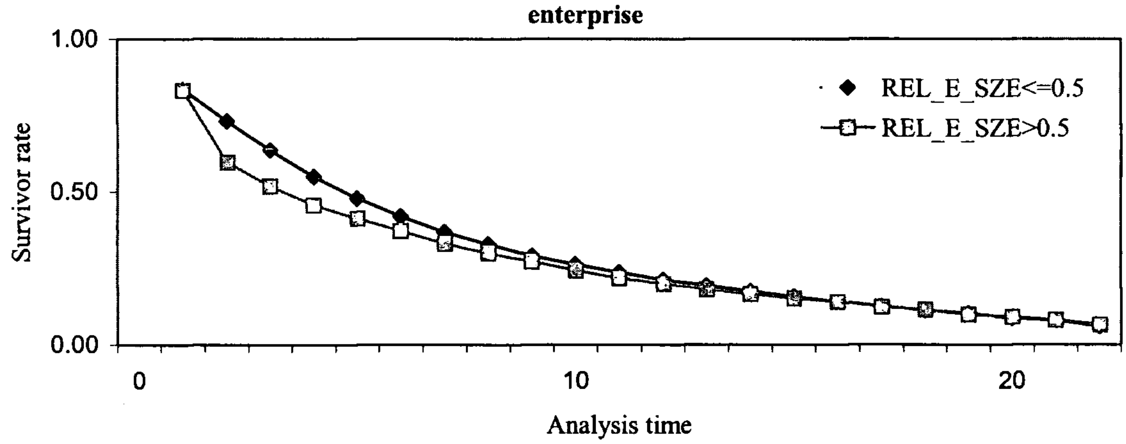


Table 5.18 Cox regression based test for equality of survivor curves, by relative size of the multi-plant enterprise

	Events observed	Events expected	Relative hazard
REL_E_SZE<=0.5	28749	29288	0.9826
REL_E_SZE>0.5	5039	4501	1.1212
Total	33788	33788	1

Wald χ^2 (1) = 31.43; Pr> χ^2 =0.0000

In order to examine the impact of the displacement effect in industries on the survivor rates of plants, industries are divided into two different groups, based on the magnitude of their entry rate, and the survivor rate of their plants are compared. As is evident from Table A5.37 in the Appendix and Figure 5.19, plants operating in industries with a high entry rate have lower survivor rates compared to plants operating in industries with a low entry rate. In this case, the value of the χ^2 test is highly significant and, therefore, we can reject the null hypothesis that there is no significant different between the two survival curves (see Table 5.19).

Figure 5.19 Kaplan-Meier survivor estimate, by the magnitude of the displacement effect

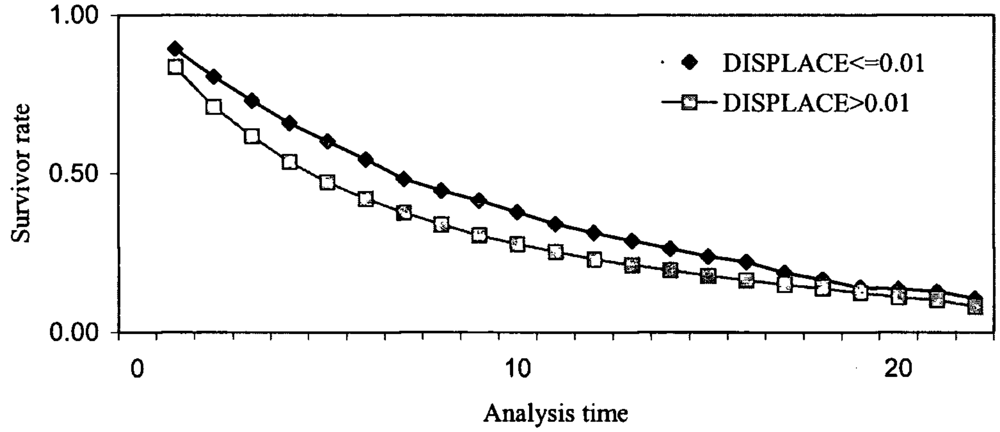


Table 5.19 Cox regression based test for equality of survivor curves, by the magnitude of the displacement effect

	Events observed	Events expected	Relative hazard
DISPLACE<=0.01	4106	5192	0.7873
DISPLACE>0.01	32385	31300	1.0405
Total	36491	36491	1

Wald χ^2 (1) =89.92; Pr> χ^2 =0.0000

Finally, industries are divided into two groups based on the value of their growth rate of output and the survivor rate of their plants in comparison with each other. Table A5.38 and Figure 5.20 shows that plants that are operating in industries with a lower than average growth have lower survival rate compared to plants operating in industries with a higher than average growth. This difference is significant as it is clear from the value of the χ^2 test in Table 5.20.

Figure 5.20 Kaplan-Meier survivor estimate, by industry growth

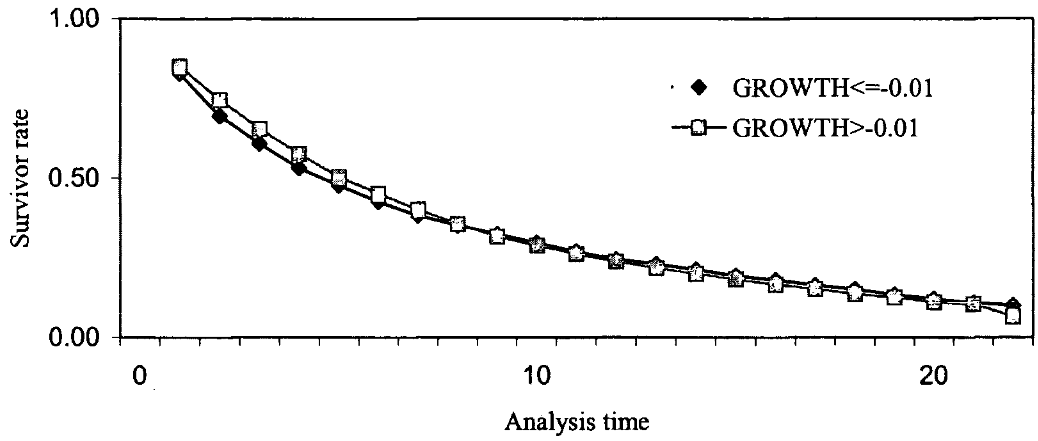


Table 5.20 Cox regression based test for equality of survivor curves, by industry growth

	Events observed	Events expected	Relative hazard
GROWTH<=-0.01	18942	18445	1.0275
GROWTH>0.01	17549	18046	0.9727
Total	36491	36491	1

Wald χ^2 (1) =8.37; Pr> χ^2 =0.0038

What can be concluded from the information in this section is that the survivor rate of plants depends on a variety of plant, owner-enterprise and industry specific factors. At the same time, the effect of these factors on the survivor rate of plants can vary depending on the age of plants. However, in this section no other factors were controlled for when examining the effect of a specific factor on the survivor rates. Therefore, in the next section, using the time variant Cox model, all the factors that might affect the survivor rate of plants are controlled for in order to obtain the pure impact of a given variable. The associated impacts will be examined also in conjunction with the age of plants, as these impacts can significantly vary with age.

5.3.4.2 Time dependent covariates Cox model

In this section, the time dependent covariates Cox model is applied to the plants in the selected file in the ARD[25] that entered the U.K. manufacturing sectors during the 1974-95 period. These plants have been weighted in order to be a true representative of the entire population of plants that entered the U.K. manufacturing sectors during the 1974-95 period. Based on the time dependent covariates Cox model, the hazard rate for a given plant at time t is calculated according to the following equation:

$$h(t) = h_0(t)\exp(\beta' x(t)) \tag{14}$$

$h_0(t)$ is defined as the baseline hazard[26] at time t, β is the parameter vector to be estimated and $x(t)$ is a vector, containing the value of the covariates for plant i. In this study, no functional form is specified for the baseline hazard component, $h_0(t)$, as that might lead to a misspecification error. Therefore, the chosen model is a semi-parametric hazard model. The baseline hazard is allowed to differ across 5 different sub-groups of plants, based on the value of the Herfindahl measure of concentration at the 4-digit industry level to which plants are allocated[27]. The estimated model gives a higher log-likelihood function and a better result as compared to when model was estimated using only a single base-line hazard.

The time variant Cox model in STATA (version 7) is used to estimate the model, which makes it possible to take a full account of censoring[28]. The covariates, $x(t)$'s, are explained in Table 5.1. The continuous variables entered the model in log-form. With the exception of the 200 industry dummies, the 11 regional dummies, the dummies accounting for the period in which plants opened and the dummy related to the GB

[25] Explained in Section 3.2.
[26] The baseline hazard is the value of hazard rate when all the covariates for the individual i are equal to zero.
[27] The STATA package used for estimation allows stratification for up to 5 sub-groups. The other sub-grouping of plants (e.g. by broad industry sub-groups; high-tech and low-tech sub-groups; capital versus labour intensive sub-groups) were tested but it was found that using the Herfindalh concentration index provided superior results. Given that this index is often used as a proxy for barriers to entry, this outcome seems appropriate
[28] See the Appendix to this Chapter.

intermediate or development area, all the other variables entered the model a second time multiplied by age of the plants, in order to find out how their impact varies with age. A general to specific modelling strategy was then employed and only the significant interaction terms were kept in the model (the insignificant regional and 4-digit SIC dummies were also excluded). The final model was tested against the original form and the value of the χ^2_{46} test was insignificant. Therefore, the null hypothesis, that the excluded variables had zero parameter coefficients, could not be rejected. Table 5.21 reports the results from estimating equation (14) and Table 5.22 shows the estimated parameters of the hazard function (e^{β}-1) only for those variables that had a significant interaction term with age (the figures reported in Table 5.22 are median values).

Within the category of foreign owned plants, those belonging to the South East Asian, SEA_{it}, and other foreign countries, O_FO_{it}, have a significantly lower likelihood of closure compared to UK-owned plants. However, the evidence is weak for the US-owned, US_{it}, and EU-owned plants, EU_{it}. In the case of plants belonging to other foreign countries, O_FO_{it}, the associated effect diminishes with the age of plants, so that after being in operation for over 5 years, plants in this category have significantly higher likelihood of closure compared to UK-owned plants. On average, a South East Asian-owned plant has some 30% lower chance of closure compared to a UK-owned plant[29]. On the other hand, plants belonging to other foreign countries, having been in operation for only one year, are almost 14% less likely to be closed (see the variable O_FO_{it} in Table 5.22). However, this impact decreases with the age of these plants, to the extent that plants over ten years of age have a 64% higher chance of closure relative to UK-owned plants.

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[29] Column (2) in Table 5.21 is the estimated e^{β}. Based on equation (14), hazard ratio for plant i relative to plant j is calculated as $h_i(t) / h_j(t) = e^{\beta(x_i - x_j)}$. Therefore, e^{β}-1 shows the percentage that the hazard rate for plant i is higher/lower than that for plant j. In this case, plants belonging to South East Asian countries had almost 30% (69%-1) lower chance of closure compared to UK-owned plants.

Table 5.21 Parameter estimates of the weighted hazard model for UK manufacturing industry, 1974-95

Variable	$\hat{\beta}$ (1)	$e^{\hat{\beta}}$ (2)	*z-values* (3)
Plant Specific Factors			
US_{it}	-0.063	0.939	-1.36
EU_{it}	-0.078	0.925	-1.35
SEA_{it}	-0.361	0.697	-2.46**
O_FO_{it}	-0.198	0.821	-1.90***
$O\_FO_{it} \times AGE_{it}$	0.050	1.051	4.37*
$Greenfld_i$	-0.042	0.96	-0.47
ΔFO_{it}^{74-79}	0.396	1.486	2.37**
$\Delta FO_{it}^{74-79} \times AGE_{it}$	-0.039	0.962	-2.57*
ΔFO_{it}^{80-89}	0.301	1.351	3.89*
ΔFO_{it}^{90-95}	0.264	1.303	2.60*
ΔOWN_{it}^{74-79}	0.271	1.311	3.42*
$\Delta OWN_{it}^{74-79} \times AGE_{it}$	-0.018	0.982	-2.68*
ΔOWN_{it}^{80-89}	0.250	1.284	7.75*
ΔOWN_{it}^{90-95}	0.334	1.397	9.98*
$SINGLE_{it}$	-0.685	0.504	-5.30*
$SINGLE_{it} \times AGE_{it}$	-0.051	0.950	-3.63*
$\ln START\_EMP_i$	0.026	1.026	1.29
$\ln START\_EMP_i \times AGE_{it}$	-0.003	0.997	-1.61
$\ln EMP_{it}$	-0.241	0.786	-12.54*
$\ln REL\_P\_SZE_{it}$	0.057	1.058	3.27*
$\ln REL\_P\_SZE_{it} \times AGE_{it}$	-0.005	0.995	-2.98*
$\ln CAP\_LAB_{it}$	0.032	1.032	5.20*
$\ln CAP\_LAB_{it} \times AGE_{it}$	-0.008	0.992	-5.38*
$\ln T\_EFF_{it}$	-0.183	0.832	-6.38*
$\ln T\_EFF_{it} \times AGE_{it}$	0.007	1.007	1.82***
IA_{it}	-0.008	0.992	-0.38
$East\_Anglia_{it}$	-0.172	0.842	-3.29*
$Yorks\_Humberside_{it}$	-0.077	0.926	-2.06**
$Northern_{it}$	-0.103	0.903	-2.04**
$Scotland_{it}$	-0.247	0.781	-6.49*
$N\_Ireland_{it}$	-0.204	0.816	-3.02*
$OPEN_{it}^{80-84}$	0.247	1.281	6.95*
$OPEN_{it}^{85-89}$	0.488	1.629	15.06*
$OPEN_{it}^{90-95}$	0.877	2.403	24.74*
Owner-enterprise Specific Factors			
$\ln REL\_E\_SZE_{it}$	0.078	1.081	4.55*
$\ln REL\_E\_SZE_{it} \times AGE_{it}$	-0.006	0.994	-3.23*
Industry Specific Factors			
$\ln DISPLACE_t$	0.236	1.266	9.46*
$\ln DISPLACE_t \times AGE_{it}$	-0.011	0.989	-3.31*
$\ln GROWTH_t$	0.239	1.270	2.77*
$\ln GROWTH_t \times AGE_{it}$	-0.035	0.966	-3.17*
54 significant 4-digit SIC dummies			

Log Likelihood = -207920.04; zero-slopes LR $\chi^2(95)$=4603.85; no of plants = 70,953; no of closures observed = 25,312; no of observations = 259,748

Table 5.22 Median parameter estimates $e^{\beta}-1$ by age sub-group in years (based on Table 5.21)

	$AGE <= 1$	$1 < AGE <= 5$	$5 < AGE <= 10$	$AGE > 10$
Plant Specific Factors				
O_FO_i	-0.137	-0.047	0.163	0.647
ΔFO_{it}^{74-79}	0.430	0.324	0.135	-0.133
ΔOWN_{it}^{74-79}	0.287	0.240	0.152	0.012
$SINGLE_{it}$	-0.521	-0.568	-0.647	-0.753
$\ln START\_EMP_i$	0.023	0.016	0.002	-0.021
$\ln REL\_P\_SZE_{it}$	0.053	0.044	0.024	-0.009
$\ln CAP\_LAB_{it}$	0.024	0.008	-0.024	-0.078
$\ln T\_EFF_{it}$	-0.162	-0.150	-0.126	-0.083
Owner-enterprise Specific Factors				
$\ln REL\_E\_SZE_{kt}$	0.075	0.063	0.039	0.000
Industry Specific Factors				
$\ln DISPLACE_t$	0.253	0.227	0.176	0.092
$\ln GROWTH_t$	0.226	0.143	-0.006	-0.223

These results are at odds with the findings of Colombo and Delmastro (2000), in that they found that foreign owned plants had a significantly higher chance of closure compared to the domestic plants.

The variable *Greenfld$_i$*, denoting those plants that have been set up by a foreign company, has no significant impact on the likelihood of closure of such plants, relative to other plants. However, the evidence is quite different when one compares the risk of closure for plants that were acquired by foreign companies (the variables ΔFO_{it}^{74-79}, ΔFO_{it}^{80-89} and ΔFO_{it}^{90-95} in Table 5.21). Acquisitions by foreign enterprises, significantly increases a plant's likelihood of closure. However, there is a significant age factor attached to the risk of closure of plants that were acquired during the 1974-79 period. The associated risk reduces as they age. A one year old plant that was acquired by a foreign company during the 1974-79 period, on average had a 43% higher chance of closure as compared to a plant that did not change ownership during that period.

However, a ten years old plant that changed ownership during the same period had a 13% lower chance of closure compared to a plant that did not change ownership during that period. Plants that were acquired during the 1980-89 and the 1990-95 period, on average, were some 35% and 30%, respectively, more likely to be closed in the years following acquisition[30]. Overall, the positive impact of foreign acquisitions on the risk of closure of acquired plants can be due to the cultural differences between the home and the host country, which was referred to by Caves (1996) as the fixed costs of learning how things are done in the host country. These findings support the findings of Li (1995), McCloughan and Stone (1998) and Harris and Robinson (2002), in that they found that foreign acquisition significantly lowered likelihood of survival. McCloughan and Stone (1998) also found that the older plants that were taken over by foreign enterprises had a higher likelihood of survival in comparison to the younger plants, although, in the current study this effect was observed only for those plants that were acquired during the 1974-79 period.

Evidence is very much the same when one looks at the variables ΔOWN_{it}^{74-79}, ΔOWN_{it}^{80-89} and ΔOWN_{it}^{90-95}, denoting changes of ownership within or to UK-owned sectors during the associated periods. However, in this case the effects are generally lower compared to those for the change into foreign ownership (except for the 1990-95 period). Plants that changed ownership within or into a UK-owned sector during the 1974-79 period had a higher chance of closure post-acquisition compared to those that did not change ownership during that period, although this effect reduces with the age of plants. Risk of closure for a one year old plant that changed ownership during this period is 28% higher than for a plant that did not change ownership, while the

[30] Examination of the raw data in Table A5.24 shows that 13% of plants that were acquired by foreign enterprises, during the 1974-95 period, closed within 1 year post-acquisition, 22% within 0-2 years and almost 35% within 0-3 years. This shows that 65% of the plants that were taken over by a foreign enterprise remained open for a significant period before they were closed.

associated impact on the risk of closure for a ten year old plant is only 1.2%. Plants that changed ownership within or to a UK-owned sector during the 1980-89 and 1990-95 period, *ceteris paribus,* had 28% and 39%, respectively, had higher chances of closure compared to those that did not change ownership. These finding show that change in ownership in general has a detrimental effect on plant survival (this effect is found after controlling for a range of factors including size an technical efficiency). This suggests that there is problems associated with assimilating such plants. The current findings contradict those found by McGuckin and Nguyen (2001) in that they found that change in ownership had a negative impact on the risk of closure of US-owned plants during the 1977-87 period. This negative impact was found when change in ownership was treated as an exogenous variable. However, once it was treated as an endogenous variable and the size and productivity of plant were also taken into account as a composite variable with change in ownership dummy, it had a positive impact on the risk of closure. This meant that change of ownership had a negative impact on the risk of closure of the larger and the more productive plants.

The variable $SINGLE_{it}$ has a significant negative coefficient, which strengthens with the age of plants. This means that a one year old single plant, on average, is 52% less likely to be closed compared to a plant that is owned by a multi-plant organization, while a ten year old single plant is 75% less likely to be closed (see Table 5.22). Our findings therefore support those studies that argue that for single plant enterprises closure is the last resort, which imposes re-entry costs on the enterprises if they want to restart their operation, while multi-plant enterprises prefer plant closure to reduction in capacity across all their plants. These results are in line with the findings by Baden-Fuller (1989), Audretsch and Mahmood (1995), Mata *et al.* (1995) and Colombo and Delmastro (2000) in that they found that the chances of survival for single plants were higher than for plants belonging to multi-plant organizations. However, the current finding contradicts those found by Disney *et al.* (1999) in that they found that single plants were initially more likely to survive, but after a year were less likely to do so[31].

Initial size, denoted by the variable $ln\ START\_EMP_i$, has a positive impact on the hazard rate of closure, although the relationship is negative for older plants (see Table 5.22). This indicates that older plants with a larger initial size are more likely to survive as they age. This finding is counter to expectations, as in the previous literature initial size is found to have a positive impact on plant survival (Mata and Portugal, 1994). In order to consider the positive relationship between the initial size and likelihood of survival, following Mata *et al.* (1995), it is possible to reformulate the results and find the impact of initial size, growth from initial size and age on the likelihood of survival of plants. The following relationship between these variables is obtained:

$$-0.215\ ln\ START\_EMP_i - 0.241\ ln\ (EMP_{it} \div START\_EMP_i) - 0.003\ (ln\ START\_EMP_i) \times AGE_{it} \qquad (15)$$

This relationship shows that the higher the initial size of a plant, the lower is its risk of closure. At the same time, there is an additional negative impact on the hazard of plants closure, the more they grow from their initial size and the older they become (this is evident by examining the coefficients associated with the $ln\ (EMP_{it} \div START\_EMP_i)$ and $(ln\ START\_EMP_i) \times AGE_{it}$ variables, respectively). Current size is more important than the initial size, which indicates that larger plants are less likely to exit. This findings are in line with the models proposed by Jovanovic (1982) and Ericson and Pakes (1995) in that they showed that learning by doing (denoted by the age of plants) and growth had a positive impact on the likelihood of survival of plants. This implies that the more plants learn about their changing market conditions and the closer they

[31] They also used the ARD in their study but their units of analysis were establishments (reporting units) rather than plants. In their case, closure did not happen unless all plants belonging to that establishment closed.

operate to the minimum efficient scale the more likely they are to survive. The current findings are, also, in line with the previous findings by Dunne *et al.* (1989), Audretsch (1994), Mata and Portugal (1994), Audretsch and Mahmood (1995), Boeri and Bellman (1995) and Doms *et al.* (1995) in that they found that initial size, growth from initial size and age had a positive impact on the likelihood of survival.

The variable $ln\ REL\_P\_SZE_{it}$ has a significant positive impact on the hazard of closure of plants, which weakens with their age. This means that larger plants belonging to multi-plant enterprises are more likely to be closed compared to the smaller plants. However, the older they become the weaker is the associated impact. In this case, a 200% increase in the size of a multi-unit plant[32] that has been in operation only for one year, increases its risk of closure by 10.6%, while the associated impact on the risk of closure of a multi-unit plant that has been in operation for over ten years is -1.8%. The current finding contradicts the finding by Dunne *et al.* (1989) in that they found a negative relationship between the size of plants belonging to a multi-plant enterprise and its likelihood of failure. It also contradicts the theory proposed by Reynold (1988) that in declining industries large firms reduce capacity by first closing down the smallest and the highest cost branch plants.

Exit barriers, measured by $ln\ CAP\_LAB_{it}$, which are mainly created through sunk costs, have a positive impact on plants' risk of closure. However, this impact weakens with the age of plants, to the extent that for plants that are operating for over 5 years the associated impact is negative. From Table 5.22 one can see that a 200% increase in $ln\ CAP\_LAB_{it}$ increases the risk of closure for plants that have been in operation for one year by 4.8% and for plants that have been in operation between 1 and 5 years by 1.6%. On the contrary, the associated impact on the risk of closure of plants that have been in

[32] The ratio of the standard deviation to the mean of the relative plant size (across all manufacturing sectors) during the 1974-95 period is about 200%.

operation between 5 and 10 years and over 10 years are –4.8% and –15.6%, respectively. The current finding is in line with the findings by Colombo and Demlastro (2000, 2001) in that they also found that investment decisions were more irreversible in older plants who were more attached to their industries, while younger more capital intensive plants exhibited higher fixed (as opposed to sunk) costs and therefore had more flexibility to leave.

The variable $ln\ T\_EFF_{it}$, which denotes the technical efficiency of plants, has a negative impact on their likelihood of closure, although this effect weakens with the age of plants. This means that the younger technically efficient plants have a lower risk of closure in comparison to the older plants that are equally technically efficient. This suggests that plant exits, on average, result in a cleansing effect, freeing resources for more innovative companies and alternative investment opportunities. However, older plants resist this process of creative destruction better than their younger counterparts. In this case, a 200% increase in $ln\ T\_EFF_{it}$ decreases the likelihood of closure of one year old plants by 32.4%, while the associated impact on the likelihood of closure of plants that have been in operation for over 10 years is only 16.6%. This finding is in line with the findings by Doms *et al.* (1995), Oulton (2000) and Aw *et al.* (2001), although they used productivity measure instead of technical efficiency measure. They found that the more productive plants had a lower risk of closure in comparison to the less productive plants.

The significant regional dummies are reported in Table 5.21. They all have a significant negative coefficient, which means that those plants located in the regions of East Anglia, Yorkshire and Humberside, North, Scotland and Northern Ireland, *ceteris paribus,* have a lower likelihood of closure compared to plants located in other regions. Taking the $Northern_{it}$ variable as an example, the associated coefficient shows that plants located in the Northern region have a 9.7% lower chance of closure compared to plants located in other regions. The impact of the regional dummies can be better explained when it is looked at in association with the variable IA_{it}, which is a dummy denoting the GB intermediate or development areas. Most of the regions mentioned above qualify for government grants. This can be the reason for the insignificant impact of IA_{it} on the likelihood of closure of plants, when these dummies are also present in the model. However, the spatial evidence is mixed; certain regions such as Wales and North west that are strongly associated with the regional assistance do not have a significant impact on the likelihood of closure of plants, while in Northern Ireland, which is not a development area it remains significant.

The cohort dummies show that the risk of closure for the later cohorts of entrants increased. For example, plants that opened during the 1990-95 period were some 140% more likely to be closed in comparison to plants that opened during the 1974-79 period. The size of a multi-plant enterprise, measured by the variable $ln\ REL\_E\_SZE_{kt}$, has a positive impact on the risk of closure of plants belonging to it. However, as plants get older the associated impact reduces. This finding suggests that larger enterprises cut capacity to a greater percentage than smaller enterprises. In this case, a 200% increase in the size of a multi-plant enterprise increases the chance of closure for a one year old plant that belongs to it by 15%, while the associated impact on the risk of closure of a plant that has been in operation for over 10 years and is under its control is almost equal to zero. This finding is in line with the finding by Lieberman (1990) that, *ceteris paribus*, a firm's capacity share of industry has a positive impact on the likelihood of closure of plants under its control.

The displacement effect, measured by the variable *ln* $DISPLACE_t$, has a positive impact on the risk of closure of plants, although the effect weakens with the age of the plant. In this case, a 200% increase in the displacement effect increases the likelihood of closure of one year old plants by 50.6%, while the associated impact on the likelihood of closure of plants that have been in operation for over 10 years is 18.4%. These results are in line with the findings by Mata and Portugal (1994) and Boeri and Bellman (1995) in that they found that plants operating in industries, characterised with a high entry, had a higher chance of closure. However, it was found that this effect was stronger for the younger plants. This finding is due, partly, to the way that hazard rate is defined in this study. It is calculated by using the number of plants in the last year of their operation. In this case, high entry rates, in a given period, can result in a large number of new plants that might operate only for one year, which, subsequently, increases the hazard rate for that period. The reason for this effect is the negative impact of age and size on plant survival (Dunne *et al.* 1989; Audretsch, 1994; Mata and Portugal, 1994; Audretsch and Mahmood, 1995; Boeri and Bellman, 1995; Doms *et al.* 1995). Hence, the positive impact of entry rates on risk of closure of plants is due both to the displacement effect and the negative impact of age and size on plant survival.

Finally, the effect of cyclical upturns and downturns is captured through the variable *ln* $GROWTH_t$. It was found that industry growth has a positive impact on the risk of closure of the younger plants, while the associated impact on the risk of closure of the older plants was negative. From Table 5.22 it is evident that a 200% increase in *ln* $GROWTH_t$ increases the risk of closure for the younger plants, by 45.2%-28.6%, but it decreases the risk of closure for plants older than 10 years, by 1.2%-44.6%. These findings are in line with the previous findings by Mata *et al.* (1995) in that they found that industries characterised with high entries and high growth faced higher exit rates.

However, in this study, this was found only for the younger plants. Given the positive impact of the displacement effect on the risk of closure, it is likely that industry growth results in a large number of new plants being established that are not viable and, therefore, close shortly after entry. Using the ARD, Disney *et al.* (1999) also found that industry growth had a positive impact on plant closures, which declined with age[33].

5.4 Summary and Conclusions

In this chapter, using the ARD[34], the closure decision of plants that opened in the U.K. manufacturing sectors during the 1974-95 period was studied. Using a hazard model, a wide range of variables were used, of which some of them were also linked to the age of the plants. The findings were mainly in line with those of previous studies. However, some interesting results were found when the age factor was also taken into account.

It was found that plants owned by the European Union countries were less likely to be closed compared to UK-owned plants. On the other hand, plants owned by other foreign countries ('other foreign countries' means countries other than United States and South East Asian countries) were less likely to be closed in the first five years after opening, but more likely to be closed afterwards.

Plants that were set up by a foreign enterprise had neither more nor less likelihood of closure as compared to UK owned plants. Acquisitions, either by a foreign or a UK enterprise, had deteriorating impacts on the likelihood of survival of the acquired plants. This can be associated with problems in assimilating acquired plants into the existing organization, which, subsequently, increases the likelihood of closure for such plants.

[33] The 4-digit industry intercept dummies are not reported in Table 5.21. However, they were generally significant, showing marked differences in the risk of closure of plants across different 4-digit manufacturing sectors. For instance, plants belonging to the wheeled tractors industry (a branch of agricultural machinery), *ceteris paribus,* were 181% more likely to exit, while plants in the ready-mixed concrete sector were 48% less likely to close during the 1974-1995 period.

[34] Explained in Section 3.2.

However, the impact of acquisitions during the 1974-79 period, either by a foreign or a UK enterprise, on the likelihood of survival of the acquired plants decreased as these plants got older.

Single-unit plants were less likely to be closed than multi-unit plants and this effect was found to be stronger for the older plants. This finding supported the argument that for single-plant enterprises plant closure is the last resort, which results in complete dissolution of the enterprise, while for multi-plant enterprises this is not the case. However, the chances of closure was higher for an older multi-unit plant, compared to a single-unit plant of the same age.

Larger multi-unit plants were more likely to be closed in comparison to the smaller multi-unit plants. However, this effect was stronger for the younger plants. This finding was contrary to the previous findings that multi-plant enterprises closed their smallest and highest cost branch plants first.

It was, also, found that larger multi-plant enterprises were more likely to close their branch plants compared to the smaller multi-plant enterprises. This effect was, also, found to be stronger on the younger plants. This showed that larger multi-plant enterprises cut capacity by a greater percentage than the smaller multi-plant enterprises and they did so by closing their younger plants first.

Initial size, growth from initial size and age of a plant were found to increase its chances of survival. However, current size had a stronger impact on the likelihood of survival of plants than the initial size. This showed that the ability of plants to learn about their changing market conditions directly affected their chances of survival. At the same time, larger plants, due to operating closer to the minimum efficient scale, were more likely to survive. The greater the growth of plants from their initial size, the less important became the initial size.

Younger plants with a greater level of capital intensity were found to have higher chances of closure compared to the older plants. This implies that in younger plants costs are more fixed (as opposed to sunk), which can be recovered in case of closure. This increases their flexibility and their chances of closure. However, for older plants costs are more sunk, which makes them more attached to a specific industry.

A higher level of technical efficiency was found to increase a plant's chance of survival. However, this effect diminished, as plants got older. This suggests that plant exit should, on average, result in a "cleansing effect", improving the overall competitiveness, freeing resources for alternative investment opportunities, and making room for more innovative companies. However, older plants manage better to resist this process of "creative destruction".

Plants located in the regions of East Anglia, Yorkshire and Humberside, North, Scotland and Northern Ireland were less likely to be closed compared to plants located in other regions. This effect was expected, as the majority of these regions qualify for government grants, which aims to increase the survival chances of plants in such regions. In this case, the presence of the regional dummies makes the dummy for GB intermediate or development areas insignificant. This finding could potentially have implications for government policy. As less efficient plants are more likely to be closed and the provision of capital grants by government increases a plant's chance of survival, the role of such grants seems less than perfectly straightforward. The understanding is that these grants should not be employed to aid the survival of plants with a lower level of efficiency; this supports the conclusion reached by Harris (2001).

Plants operating in industries characterised with a high entry have higher chance of closure as compared to plants operating in industries characterised with a low entry. However, this effect is found to be stronger on the younger plants. This shows that new entrants can displace the incumbents to a large extent, although the older plants, either due to their larger size or higher level of experience, can resist the displacement effect better than the younger plants.

Finally, plants operating in industries characterised with high growth are more likely to be closed if they are young and less likely to be closed if they are old. Combining the effect of displacement and growth, it can be concluded that high growth industries result in a large number of new plants that are not viable and, subsequently, exit.

At this point, a summary of the major findings seems appropriate. Among the plant specific factors, cohort dummies and change in ownership (either to a foreign or to a UK enterprise) had the highest positive impact upon the plants' chances of closure. On the contrary, plants belonging to South-East-Asian countries, plants with a higher level of employment, those located in East-Anglia, Northern region, Scotland and Northern Ireland, single plants and plants with a higher level of efficiency were among those with the lowest chances of closure. Industry specific variables such as displacement and growth were also very important in terms of their effect on the hazard rate of closure of plants.

It also became evident that age had both a direct and an indirect impact upon a plant's likelihood of closure. It directly decreased it and indirectly changed the magnitude or even the direction of the impact of certain variables upon it.

What can be concluded from the above findings is that exit decision is a multi-dimensional one and the various characteristics of plant, enterprise, industry, region and time can affect it. The history attached to a specific plant has an important impact upon its likelihood of failure. The only way to take account of this history is to employ a model that accommodates the plant-specific factors as well as the industry, owner-enterprise and time specific factors and takes account of any changes that happen in their value as plants age. This highlights the salient feature of the chosen model (time varying Cox model) in that it is capable of accommodating all these factors. It also shows that those econometric models that take a measure of exit, e.g. gross exit or exit rate at an industry level, and try to explain its variations using some industry-level variables (such as barriers to exit, growth and profitability) have major shortcomings.

5.5 Appendix to Chapter 5

Right censoring

All plants that survived beyond 1995 are censored. However, as an unbalanced panel data is used here there are, also, a number of occasions when plants that existed during the 1974-95 period are not observed to exit during the time they are believed to be at risk in the model. This is because they were not sampled by ONS to be included in the ABI during that interval in which they failed (but because the population data is available, we know that they indeed failed before 1996). This has no impact on the model being estimated (which takes account of such censoring), but it is important not to impute the rate of closure from the diagnostic statistics obtained from the estimated model.

Table A5.23 Survivor rates, by greenfield entry.

Time, t_j	$greenfield_i$=0	$greenfield_i$=1
1	0.8405	0.8308
2	0.7189	0.7325
3	0.6315	0.6297
4	0.5555	0.5321
5	0.4935	0.4679
6	0.4428	0.4052
7	0.3973	0.3490
8	0.3588	0.3176
9	0.3244	0.2894
10	0.2964	0.2565
11	0.2708	0.2285
12	0.2461	0.2074
13	0.2271	0.1909
14	0.2101	0.1689
15	0.1923	0.1446
16	0.1774	0.1270
17	0.1606	0.1190
18	0.1465	0.1176
19	0.1325	0.1013
20	0.1184	0.0909
21	0.1093	0.0782
22	0.0879	0.0531

Table A5.24 Survivor rates, by Change to foreign ownership during 1974-79 period.

Time, t_j	ΔFO 74-79 =0	ΔFO 74-79 =1
1	0.8396	1.0000
2	0.7193	0.8743
3	0.6304	0.7869
4	0.5529	0.6566
5	0.4905	0.6119
6	0.4390	0.5168
7	0.3923	0.4802
8	0.3542	0.4565
9	0.3204	0.4073
10	0.2921	0.3673
11	0.2667	0.3028
12	0.2422	0.2776
13	0.2232	0.2638
14	0.2059	0.2261
15	0.1881	0.1899
16	0.1729	0.1749
17	0.1566	0.1691
18	0.1439	0.1427
19	0.1295	0.1378
20	0.1156	0.1278
21	0.1060	0.1250
22	0.0848	0.0988

Table A5.25 Survivor rates, by Change to foreign ownership during 1980-89 period.

Time, t_j	ΔFO 80-89 =0	ΔFO 80-89 =1
1	0.8396	1.0000
2	0.7197	0.7730
3	0.6306	0.7049
4	0.5526	0.6380
5	0.4916	0.4904
6	0.4401	0.4098
7	0.3935	0.3710
8	0.3556	0.3319
9	0.3213	0.3076
10	0.2928	0.2825
11	0.2683	0.2242
12	0.2433	0.2123
13	0.2249	0.1855
14	0.2077	0.1614
15	0.1891	0.1499
16	0.1746	0.1266
17	0.1582	0.1192
18	0.1450	0.1067
19	0.1317	0.0826
20	0.1188	0.0590
21	0.1090	0.0590
22	0.0864	0.0590

Table A5.26 Survivor rates, by Change to foreign ownership during 1990-95 period.

Time, t_j	ΔFO 90-95 =0	ΔFO 90-95 =1
1	0.8396	1.0000
2	0.7196	0.7840
3	0.6312	0.5472
4	0.5534	0.4715
5	0.4914	0.3917
6	0.4394	0.3631
7	0.3930	0.3127
8	0.3554	0.2528
9	0.3218	0.2054
10	0.2934	0.1817
11	0.2672	0.1723
12	0.2432	0.1355
13	0.2243	0.1184
14	0.2068	0.1018
15	0.1886	0.0885
16	0.1733	0.0840
17	0.1588	0.0482
18	0.1453	0.0464
19	0.1311	0.0422
20	0.1171	0.0386
21	0.1081	0.0328
22	0.0859	0.0328

Table A5.27 Survivor rates, by Change to or within UK owned sector during 1974-79 period.

Time, t_j	ΔOWN 74-79 =0	ΔOWN 74-79 =1
1	0.8396	1.0000
2	0.7190	0.8829
3	0.6294	0.7996
4	0.5526	0.6803
5	0.4901	0.6120
6	0.4387	0.5406
7	0.3922	0.4840
8	0.3539	0.4451
9	0.3197	0.4075
10	0.2905	0.3849
11	0.2646	0.3521
12	0.2422	0.2966
13	0.2228	0.2795
14	0.2056	0.2529
15	0.1872	0.2319
16	0.1719	0.2153
17	0.1553	0.2018
18	0.1417	0.1889
19	0.1266	0.1798
20	0.1149	0.1505
21	0.1052	0.1418
22	0.0941	0.0698

Table A5.28 Survivor rates, by Change to or within UK owned sector during 1980-89 period.

Time, t_j	ΔOWN 80-89 =0	ΔOWN 80-89 =1
1	0.8396	1.0000
2	0.7188	0.8767
3	0.6312	0.7491
4	0.5566	0.6159
5	0.4972	0.5199
6	0.4460	0.4555
7	0.3996	0.4029
8	0.3618	0.3605
9	0.3275	0.3247
10	0.2997	0.2926
11	0.2790	0.2526
12	0.2567	0.2235
13	0.2384	0.2034
14	0.2217	0.1844
15	0.2052	0.1637
16	0.1898	0.1489
17	0.1729	0.1344
18	0.1590	0.1223
19	0.1444	0.1091
20	0.1303	0.0961
21	0.1217	0.0863
22	0.1113	0.0553

Table A5.29 Survivor rates, by Change to or within UK owned sector during 1990-95 period.

Time, t_j	ΔOWN 90-95 =0	ΔOWN 90-95 =1
1	0.8396	1.0000
2	0.7213	0.8057
3	0.6362	0.6093
4	0.5600	0.4957
5	0.5001	0.3989
6	0.4498	0.3290
7	0.4046	0.2726
8	0.3682	0.2238
9	0.3355	0.1838
10	0.3073	0.1576
11	0.2828	0.1262
12	0.2583	0.1072
13	0.2392	0.0929
14	0.2224	0.0755
15	0.2034	0.0658
16	0.1878	0.0585
17	0.1719	0.0501
18	0.1574	0.0461
19	0.1433	0.0398
20	0.1283	0.0355
21	0.1193	0.0315
22	0.0943	0.0264

Table A5.30 Survivor rates, by state of being a single-unit plant.

Time, t_j	Other	$SINGLE_{it}$
1	0.8336	0.8787
2	0.7119	0.7736
3	0.6189	0.7212
4	0.5356	0.6897
5	0.4693	0.6653
6	0.4136	0.6465
7	0.3639	0.6332
8	0.3247	0.6105
9	0.2889	0.5950
10	0.2609	0.5630
11	0.2350	0.5362
12	0.2111	0.5155
13	0.1925	0.5026
14	0.1748	0.4942
15	0.1569	0.4833
16	0.1422	0.4724
17	0.1267	0.4649
18	0.1140	0.4549
19	0.1016	0.4301
20	0.0883	0.4145
21	0.0810	0.3858
22	0.0608	0.3780

Table A5.31 Survivor rates, by initial employment size

Time t_j	$START\_EMP_{it}$ (1-2)	$START\_EMP_{it}$ (3-10)	$START\_EMP_{it}$ (11-50)	$START\_EMP_{it}$ (51-100)	$START\_EMP_{it}$ (101-500)	$START\_EMP_{it}$ (501+)
1	0.7813	0.8316	0.8642	0.8785	0.8781	0.8595
2	0.6434	0.6898	0.7646	0.7911	0.7952	0.7900
3	0.5519	0.5813	0.6845	0.7316	0.7374	0.7451
4	0.4674	0.4936	0.6082	0.6796	0.6909	0.7127
5	0.3982	0.4286	0.5438	0.6322	0.6638	0.6565
6	0.3417	0.3739	0.4924	0.5873	0.6160	0.6097
7	0.2971	0.3239	0.4444	0.5547	0.5716	0.5703
8	0.2620	0.2868	0.4030	0.5147	0.5488	0.5176
9	0.2188	0.2581	0.3668	0.4765	0.5074	0.4944
10	0.1959	0.2283	0.3369	0.4506	0.4741	0.4780
11	0.1724	0.2080	0.3048	0.4250	0.4507	0.4576
12	0.1533	0.1879	0.2757	0.3987	0.4230	0.4400
13	0.1389	0.1718	0.2548	0.3694	0.3984	0.4083
14	0.1254	0.1529	0.2370	0.3541	0.3704	0.3341
15	0.1100	0.1348	0.2189	0.3287	0.3391	0.3131
16	0.0910	0.1192	0.2062	0.2995	0.3216	0.3043
17	0.0837	0.1073	0.1865	0.2777	0.2946	0.2859
18	0.0716	0.0985	0.1697	0.2641	0.2805	0.2859
19	0.0616	0.0843	0.1550	0.2465	0.2673	0.2745
20	0.0571	0.0721	0.1375	0.2319	0.2517	0.2745
21	0.0523	0.0672	0.1265	0.2111	0.2254	0.2565
22	0.0452	0.0471	0.1030	0.1963	0.2045	0.2565

Table A5.32 Survivor rates, by current employment of the plants

Time, t_j	EMP_{it} (1-2)	EMP_{it} (3-10)	EMP_{it} (11-50)	EMP_{it} (51-100)	EMP_{it} (101-500)	EMP_{it} (501+)
1	0.7742	0.8157	0.8609	0.8745	0.8785	0.8683
2	0.6033	0.6759	0.7684	0.7887	0.7881	0.8169
3	0.5209	0.5919	0.7010	0.7337	0.7380	0.7613
4	0.4400	0.5121	0.6381	0.6874	0.7025	0.7435
5	0.3791	0.4481	0.5823	0.6453	0.6759	0.7201
6	0.3318	0.3938	0.5339	0.6114	0.6419	0.7035
7	0.2888	0.3486	0.4937	0.5713	0.6130	0.6932
8	0.2558	0.3117	0.4522	0.5414	0.5895	0.6756
9	0.2304	0.2723	0.4201	0.5050	0.5654	0.6634
10	0.2108	0.2423	0.3880	0.4815	0.5431	0.6462
11	0.1911	0.2176	0.3594	0.4545	0.5211	0.6376
12	0.1778	0.1948	0.3298	0.4287	0.5029	0.6070
13	0.1645	0.1790	0.3106	0.4035	0.4776	0.5851
14	0.1473	0.1621	0.2931	0.3805	0.4549	0.5668
15	0.1312	0.1413	0.2739	0.3572	0.4341	0.5542
16	0.1209	0.1284	0.2545	0.3350	0.4159	0.5472
17	0.1071	0.1180	0.2346	0.3147	0.3972	0.5472
18	0.1011	0.1080	0.2151	0.2931	0.3838	0.5287
19	0.0811	0.0965	0.1976	0.2711	0.3684	0.5189
20	0.0707	0.0827	0.1744	0.2508	0.3490	0.5052
21	0.0600	0.0743	0.1632	0.2253	0.3268	0.4872
22	0.0434	0.0452	0.1387	0.2188	0.3096	0.4585

Table A5.33 Survivor rates, by the relative size of the multi-unit plants.

Time, t_j	REL_P_SZE =<0.5	REL_P_SZE >0.5
1	0.8403	0.7192
2	0.7159	0.6477
3	0.6205	0.6020
4	0.5344	0.5751
5	0.4674	0.5182
6	0.4105	0.4810
7	0.3596	0.4503
8	0.3197	0.4264
9	0.2837	0.3933
10	0.2560	0.3583
11	0.2299	0.3369
12	0.2053	0.3209
13	0.1871	0.2965
14	0.1697	0.2734
15	0.1516	0.2589
16	0.1369	0.2436
17	0.1215	0.2261
18	0.1092	0.2081
19	0.0963	0.2067
20	0.0828	0.1942
21	0.0757	0.1836
22	0.0546	0.1836

Table A5.34 Survivor rates, by the degree of capital intensity

Time, t_j	CAP_LAB=<0.003	CAP_LAB>0.003
1	0.8504	0.7861
2	0.7482	0.6213
3	0.6625	0.5341
4	0.5823	0.4666
5	0.5199	0.4123
6	0.4721	0.3652
7	0.4228	0.3264
8	0.3880	0.2930
9	0.3567	0.2636
10	0.3302	0.2393
11	0.3087	0.2166
12	0.2857	0.1961
13	0.2673	0.1803
14	0.2500	0.1656
15	0.2330	0.1504
16	0.2182	0.1380
17	0.2028	0.1250
18	0.1909	0.1143
19	0.1791	0.1029
20	0.1635	0.0919
21	0.1579	0.0844
22	0.1579	0.0670

Table A5.35 Survivor rates, by the magnitude of technical efficiency

Time, t_j	Ln T_EFF<=0.7	Ln T_EFF<=0.7
1	0.8412	0.8389
2	0.7279	0.7153
3	0.6276	0.6329
4	0.5445	0.5584
5	0.4747	0.5016
6	0.4229	0.4499
7	0.3730	0.4067
8	0.3322	0.3716
9	0.3025	0.3341
10	0.2767	0.3036
11	0.2547	0.2738
12	0.2306	0.2497
13	0.2123	0.2306
14	0.1973	0.2102
15	0.1777	0.1946
16	0.1628	0.1799
17	0.1458	0.1671
18	0.1337	0.1527
19	0.1197	0.1398
20	0.1043	0.1296
21	0.0943	0.1223
22	0.0838	0.0855

Table A5.36 Survivor rates, by the relative size of the multi-plant enterprise.

Time, t_j	REL_E_SZE=<0.5	REL_E_SZE>0.5
1	0.8338	0.8318
2	0.7304	0.5949
3	0.6349	0.5177
4	0.5481	0.4556
5	0.4778	0.4126
6	0.4194	0.3724
7	0.3684	0.3306
8	0.3280	0.2994
9	0.2907	0.2722
10	0.2628	0.2441
11	0.2372	0.2177
12	0.2122	0.1995
13	0.1936	0.1820
14	0.1754	0.1668
15	0.1572	0.1512
16	0.1416	0.1408
17	0.1264	0.1246
18	0.1131	0.1151
19	0.1020	0.0986
20	0.0869	0.0915
21	0.0802	0.0815
22	0.0595	0.0655

Table A5.37 Survivor rates, by the magnitude of the displacement effect

Time, t_j	DISPLACE=<0.01	DISPLACE>0.01
1	0.8939	0.8364
2	0.8046	0.7098
3	0.7286	0.6168
4	0.6586	0.5354
5	0.6008	0.4713
6	0.5438	0.4200
7	0.4811	0.3765
8	0.4450	0.3383
9	0.4134	0.3042
10	0.3769	0.2774
11	0.3400	0.2529
12	0.3124	0.2295
13	0.2875	0.2116
14	0.2628	0.1951
15	0.2389	0.1778
16	0.2213	0.1634
17	0.1867	0.1493
18	0.1660	0.1371
19	0.1408	0.1242
20	0.1362	0.1104
21	0.1286	0.1016
22	0.1062	0.0811

Table A5.38 Survivor rates, by industry growth

Time, t_j	GROWTH =<-0.01	GROWTH >-0.01
1	0.8939	0.8364
2	0.8046	0.7098
3	0.7286	0.6168
4	0.6586	0.5354
5	0.6008	0.4713
6	0.5438	0.4200
7	0.4811	0.3765
8	0.4450	0.3383
9	0.4134	0.3042
10	0.3769	0.2774
11	0.3400	0.2529
12	0.3124	0.2295
13	0.2875	0.2116
14	0.2628	0.1951
15	0.2389	0.1778
16	0.2213	0.1634
17	0.1867	0.1493
18	0.1660	0.1371
19	0.1408	0.1242
20	0.1362	0.1104
21	0.1286	0.1016
22	0.1062	0.0811

Chapter 6: Conclusions and Recommendations

This thesis has investigated: 1) the importance of plant entry and exit in UK manufacturing sectors during the 1974-97 period; 2) the determinants of entry decision; and 3) the determinants of exit decision. Using a newly released UK database, it proved possible to uncover some important facts regarding these aspects.

It was found that the importance of entry and exit cannot be fully captured by using raw figures alone. Various other aspects such as the size of entrants and exitors and entrants' growth after entry have to be taken into consideration if one wishes to examine the role played by entrants and exitors in UK manufacturing industries. It was found that the annual entry rates were increasing over the 1974-97 period and that the majority of entrants were small in size. At the same time the annual exit rates were also increasing. The variations in entry and exit rates at the four-digit manufacturing level were found to be of transitory nature. This implies that they were due mainly to the inter-temporal shocks. The highest entry and exit rates were observed during the periods of economic boom (the late 1970's period), which shows that entry and exit rates may be pro-cyclical.

It was found that the maturation process was a difficult one for entrants as almost 44% of them exited by their fifth year. This could be due to the fact that entrants were mainly small in size and the costs of adjustment to increase market penetration can be very high. Overall, this finding reveals that survival was not as easy as entry in UK manufacturing industries over the period under study. By dividing the study time period into 5-year intervals, it was found that: 1) survival was easier for entrants prior to 1984 and became increasingly difficult afterwards and 2) exit was not evident only among the entrants and incumbents' life was also threatened by the intensity of competition. This finding specifically reveals that the notion of "creative destruction" is of particular relevance to UK manufacturing industries[1].

The results in Chapter 4 revealed that entry decision is a complex one and is affected by various (plant, industry, geographical and time-specific) factors. Therefore, a suitable model is one that is capable of accommodating them all. The results showed that taking entrants as a homogenous group of plants can result in biased estimates of the coefficients, as different types of entrants responded differently to similar industrial, geographical and time specific factors. Therefore, entrants have to be divided into different groups based on their common characteristics. It was found that the industrial and geographical specific factors play equally important roles in the entry decision and both have to be considered.

At the same time, it became evident that the role that industry life cycle plays in determining the entry rates should not be downplayed. It was found that the type of entrants and their incentives were different for industries in different stages in their life cycle and, therefore, the entry rates varied from the early stages to the later stages. At the same time, the effect of certain industry-specific and geographical-specific variables on entry appeared to be different across the two different stages. Having such important impact upon entry rates, it can be concluded that industry life cycle has to be taken into account in any study of the entry decision.

On the other hand, it was found that in the context of UK manufacturing sectors, the fundamental differences between the northern and the southern regions of the UK also have to be taken into account. It could directly affect the entry rates, as the type of entrants and their motivations can vary across the northern and the southern regions of the UK. At the same time, it was found that the effect of certain variables (both industry

[1] It is important not to overstate the importance of churning, as for example in 1995, 71% of total manufacturing output was produced by plants that have been in operation for more than 5 years.

and geographical specific) on entry rates varied based on whether the opened plant was located in the north or the south of the UK.

In studying the exit decision of plants, it was found that various factors (e.g. plant, industry and owner-enterprise specific factors) were important. The history attached to a specific plant was found to have significant implications on its likelihood of failure[2]. This highlighted the salient feature of the chosen model (time varying Cox model), as it was capable of: 1) accommodating all these factors and 2) taking account of the changes that occurred in their values as the plants aged. The most important plant specific factors, with a positive impact upon the hazard rate of closure of plants, appeared to be cohort dummies and change in ownership. On the other hand, variables which had the highest negative impact upon the hazard rate of closure of plants were; being owned by a South-East-Asian country, being a single-unit plant, employment (number of employees), being located in the regions of East-Anglia, Northern, Scotland and Northern Ireland and efficiency. At the same time, it became evident that displacement effect and growth at the industry level were also very important in determining the plants' likelihood of failure.

Another important finding in this chapter was that the age of plants had a crucial role in determining their hazard rate of closure as the effect of some variables, such as start-up employment, displacement and growth changed as plants aged. Overall, the findings from Chapter 5 depicted that the exit decision is a multi-dimensional one, which can be affected by many different factors and any study that attempts to examine this decision inevitably has to take account of these factors.

[2] For example plants that changed ownership had significantly higher likelihood of closure compared to other plants.

Recommendations for future research

1. Chapter 3 examined the entry and exit decision at the *plant* level. However, looking at the entry and exit of *firms* can also reveal important facts and raise interesting questions. Therefore, future research can examine the importance of firm entry (either through plant creation or acquisition) and exit (either through plant closure or divesture), and their growth and decline in UK manufacturing industries.
2. The entry decision has been studied here at more detailed level than was previously done. Therefore, not only has special care to be taken in differentiating between entrants based on their characteristics, but also the role of the industry life cycle should not be ignored. Hence, future research needs to explore the type of entrants and their magnitude in UK manufacturing industries in different stages of the industry life cycle.
3. Special attention in future research should be given to the role of change in ownership in determining the risk of closure of plants and why this characteristic appears to be so important.

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